





Author Index

	PAGE		PAGE
ADIGA, P. R. .. .. .	153	Balasubramanian, A. .. .. .	223
Agarwal, G. P. .. .. .	276	Balasubramanian, A. P. .. .. .	542
Agarwal, I. P. .. .. .	118	Balasubramanian, M. .. .. .	562
Agarwal, M. K. .. .. .	193	Banerji, D. .. .. .	470
Agate, A. D. .. .. .	459	Banga, S. S. .. .. .	354
Agrawal, A. P. .. .. .	411	Baraiya, E. S. .. .. .	35
Agrawal, H. C. .. .. .	20	Baruah, J. N. .. .. .	226
Agrawal, K. C. .. .. .	13	Barua, R. K. .. .. .	257, 353
Agrawal, R. K. .. .. .	182	Basu Choudhuri, J. C. .. .. .	434
A. G. (Rev.) .. .. .	430	Batcha, M. B. G. R. .. .. .	36
Ahluwalia, M. .. .. .	321	Baxi, A. J. .. .. .	405
Ahluwalia, V. K. .. .. .	455	Beri, R. M. .. .. .	162, 324
Ahmad, Z. U. .. .. .	290	Bezbaruah, H. P. .. .. .	376
Alice Abraham .. .. .	512	Bhagavan, C. S. .. .. .	452
Alikunhi, K. H. .. .. .	103	Bhag Singh .. .. .	102, 128
Ambika Singh .. .. .	81	Bhalla, O. P. .. .. .	86
Anand, S. .. .. .	401	Bhalerao, V. R. .. .. .	503
Anand, S. C. .. .. .	202	Bhandari, D. R. .. .. .	513
Ananthakrishnan, R. .. .. .	100	Bhandari, L. L. .. .. .	359
Ananthanarayanan, S. .. .. .	561	Bhandari, N. N. .. .. .	230
Anantharaman, T. R. .. .. .	262	Bhapkar, D. G. .. .. .	92
— (Rev.) .. .. .	41	Bharat Prasad .. .. .	435
Anantheswaran, C. K. .. .. .	310	Bhargava, K. S. .. .. .	283
Anjaneyulu, A. S. R. .. .. .	67	Bhargava, S. N. .. .. .	377
Anna Mani (Miss) .. .. .	55	Bharti, S. P. .. .. .	136
Appala Raju, N. .. .. .	74	Bhatia, B. S. .. .. .	311
Arnikar, H. J. .. .. .	209	Bhatia, D. S. .. .. .	311
Arora, P. K. .. .. .	184	Bhatia, H. M. .. .. .	405
A. R. V. (Rev.) .. .. .	87, 137	Bhat, J. V. .. .. .	459, 501
A. S. G. (Rev.) 137, 285, 333, 380, 381, 431, 479, 525, 572, 573		Bhatnagar, M. P. .. .. .	179, 513
Asha Satsangi .. .. .	28	Bhatnagar, P. L. (Rev.) .. .. .	429, 476
Asok Kr. Kar .. .. .	38	Bhatnagar, Sudha .. .. .	369
A. S. (Rev.) .. .. .	477, 570	Bhatt, M. V. .. .. .	284
Atal, C. K. .. .. .	70, 354	— (Rev.) .. .. .	523
Ather H. Siddiqui .. .. .	551	Bhattacharjee, J. .. .. .	314
Atwal, A. S. .. .. .	511	Bheemasankara Rao, Ch. .. .. .	544
Avadhani, P. N. .. .. .	467	Bhimachar, B. S. (Rev.) .. .. .	526
BACHHAWAT, B. K. (Rev.) .. .. .	89	Bhore, D. P. .. .. .	92
Bagavant, G. .. .. .	208, 257, 454	Bhuyan, K. .. .. .	353
Bahl, J. S. .. .. .	13	Bilgrami, K. S. .. .. .	174, 558
Balakrishna, S. .. .. .	213	Biswambhar Saha .. .. .	554
Balakrishnan, M. P. .. .. .	222	Borreswara Rao, C. .. .. .	264, 358
Balakrishnan Nair, N. .. .. .	215	Bose, B. C. .. .. .	71
		Bose, R. B. .. .. .	
		Brahmanandam, S. .. .. .	

	PAGE		PAGE
Brahmavar, S. M. ..	254, 351, 451, 497	GANAPATI, P. N. ..	361
Brahm Dev ..	306	Ganeshsundaram, P. C. (Rev.) ..	432
B. R. S. (Rev.) ..	42, 431	Gangrade, G. A. ..	331
CASSHYAP, S. M. ..	263	Ganguly, D. ..	226
Chahal, D. S. ..	282, 328	Ganguly, J. (Rev.) ..	383
Chandola, R. P. ..	179	G. B. (Rev.) ..	335, 382, 476
Chandra, R. ..	402	Geeta Chakravarty ..	251
Chandra, V. ..	372	George, J. ..	73
Chandrasekharan, S. ..	172	George, M. G. ..	79
Chandravadana, P. ..	229	George, R. Y. ..	168
Chatterjee, A. K. ..	121	Ghose, K. C. ..	167
Chatterjee, S. K. (Rev.) ..	381	Ghurde, V. R. ..	282
Chauhan, U. P. S. ..	418	Ginwala, K. K. ..	159
Chavan, V. M. ..	92	Gopalakrishna, G. ..	207
Chopra, V. L. ..	539	Gopalan, C. ..	116
Chowdhury, J. B. ..	370	Gopinath, P. M. ..	169
C. S. P. (Rev.) ..	90	Govindan, A. ..	210
DALBIR SINGH ..	183	Govindarajan, V. S. ..	445
Damle, V. N. ..	65	Govinda Rajulu, B. V. ..	410
Das, K. ..	370	Govindu, H. C. ..	445
Das, S. C. ..	402	Goyal, R. D. ..	93
Dasannacharya, B. (Rev.) ..	187	Goyal, S. K. ..	366
Dassarma, D. ..	314	Grover, R. K. ..	398
Das Gupta, S. K. ..	123, 218	Gupta, A. B. ..	19
Datar, M. G. ..	161	Gupta, P. K. ..	180
De, A. ..	314	Gupta, R. ..	193
Deb, D. B. ..	193	Gupta, S. ..	183
Deoras, P. J. ..	163, 457	Gururaja Rao, R. ..	311
Desai, A. G. ..	15, 65	HAKOO, M. L. ..	273
Desai, D. D. ..	356	Hardev Singh ..	472
Desai, M. N. ..	256, 474	Hari Kishore ..	268
Desai, S. M. (Mrs.) ..	256	Harjit Singh ..	545
Deshmukh, G. S. ..	69	Hashim, M. ..	225
Deshpande, B. B. ..	108	Hasiya, S. K. ..	129, 279
Deshpande, Prabhakar ..	551	H. S. P. (Rev.) ..	191
Deshpande, V. T. ..	497	Husain, A. ..	81
Desikachary, T. V. (Rev.) ..	42, 190	Hymowitz, T. ..	427
Devanathan, T. ..	112	INDERJIT SINGH (Rev.) ..	287
Dev Rao ..	518	Indu Totuka (Miss) ..	179
Dhaliwal, G. K. ..	317	Iqballuddin ..	575
Dhawan, N. L. ..	102	Iyengar, M. A. ..	261
Dhokarika, B. G. ..	21	Iyer, B. H. (Rev.) ..	334
Dighe, V. S. ..	257, 454	JAGADISWARA RAO, R. ..	74
Dokras, V. M. (Rev.) ..	286	Jagathesan, D. ..	539
Dorle, A. K. ..	455	Jain, B. D. ..	66, 306
Dubey, J. P. ..	273, 329, 511	Jain, H. K. ..	369
Dutt, S. ..	80	Jain, K. ..	227
EDWARD, G. ..	320	Jain, K. B. L. ..	134
Ehasnullah Khan ..	23, 77, 363, 414	Jain, R. K. ..	118
Elayidom, N. B. ..	274	Jain, S. P. ..	434, 506
Esbeekay. (Rev.) ..	336, 384	Jairajpuri, M. S. ..	318, 508
FAROOQI, M. I. H. ..	171	Jalan, S. ..	230
		Janaki, N. ..	404
		Jana, Manas, K. ..	469

	PAGE		PAGE
Janardan Rao, Y. . . . .	461	Kshira Sagar, T. V. S. R. . . . .	79
Janardhanan, K. K. . . . .	226	Kulkarni, A. B. . . . .	112, 307
Jaya G. Iyer (Miss) . . . . .	507	Kuloor, N. R. (Rev.) . . . . .	89
Jayaraman, H. . . . .	546	Kumara Pillai, P. . . . .	33
Jijie, K. . . . .	303	Kumar, C. S. . . . .	255
Johari, D. P. . . . .	81	Kumar, R. . . . .	221
Jolly, M. S. . . . .	220	Kumkum Roy (Miss) . . . . .	269
Joshi, A. B. . . . .	371	Kundra, K. D. . . . .	302
Joshi, M. G. . . . .	38, 371	Kuppuswamy, S. . . . .	311
J. V. B. (Rev.) . . . . .	140, 335, 522	Kurup, P. A. . . . .	456
		Kurup, P. V. . . . .	408
KABADI, M. B. . . . .	15		
Kabir, V. K. . . . .	544	LA FOND, E. C. . . . .	56
Kaleysaraj, R. . . . .	456	Lakshmi, M. S. . . . .	166
Kalia, H. R. . . . .	136	Lalitha Kumari, H. (Miss) . . . . .	548
Kaliyaperumal, S. . . . .	172	Landa, S. . . . .	485
Kamath, Y. K. . . . .	72	Laloraya, M. M. . . . .	31, 279, 470
Kameswara Rao, A. . . . .	395	Leng, E. R. . . . .	202
Kameswara Rao, C. . . . .	345		
Kameswara Rao, K. . . . .	356	MADHAV, R. . . . .	151
Kamkhali, N. H. . . . .	112	Mahadevan, V. . . . .	71, 303
Kanwar, R. C. . . . .	358	Maiti, P. C. . . . .	162
Kapil, R. N. . . . .	493	Makhija, O. P. . . . .	182
Kapoor, A. S. . . . .	266	Mangalangi, N. K. (Miss) . . . . .	364
Kapoor, B. M. . . . .	325	Manohar, H. . . . .	248
Kapoor, L. D. . . . .	355	Mariamamma, T. . . . .	219
Kapur, S. L. (Rev.) . . . . .	41	Mathew, C. P. . . . .	259
Kar, A. K. . . . .	38, 555	Mathur, B. L. . . . .	420
Karnik, M. G. . . . .	324	Mathur, S. C. . . . .	290
Katagihallimath, S. S. . . . .	464	Meenakshi, G. (Miss) . . . . .	465
Kathavate, Y. V. . . . .	158	Mehra, B. . . . .	420
Kaul, K. N. . . . .	171	Mehra, K. L. . . . .	300
Kenkare, D. S. . . . .	161	Mehrotra, G. S. . . . .	574
Kenyon, J. . . . .	14, 111, 260	Mehrotra, P. N. . . . .	265
Kesavamurthy, M. J. . . . .	206	Mehta, C. M. . . . .	17, 66
Khandelwal, O. P. . . . .	126	Mehta, P. R. . . . .	445
Khan, M. A. . . . .	169	Mehta, S. C. . . . .	402
Khanna, P. K. . . . .	175	Mehta, S. M. . . . .	544
Khanna, S. . . . .	216, 508	Menon, T. U. (Miss) . . . . .	513
Khanolkar, V. R. (Rev.) . . . . .	239	Merchant, J. R. . . . .	18
Khare, M. P. . . . .	114	Mihir K. Bose . . . . .	549
Khoshoo, T. N. . . . .	235	Mishra, R. R. . . . .	177
Krishna Brahmam, N. . . . .	499	Misra, P. C. . . . .	283
Krishnamoorthi, B. . . . .	463	Mithal, R. S. . . . .	574
Krishnamoorthy, V. . . . .	16	M. K. S. (Rev.) . . . . .	43, 288, 478, 523
Krishnamurty, G. S. R. . . . .	356	Mohana Rao, P. R. . . . .	468
Krishnamurty, H. G. . . . .	453	Mohan, K. . . . .	377
Krishnan, A. A. (Rev.) . . . . .	88, 521	Mohan Ram, H. Y. . . . .	28
Krishnan, M. S. . . . .	386	Money, N. S. . . . .	26
Krishnan, S. K. . . . .	297	Moniz, L. . . . .	177
Krishna Pillai, N. . . . .	219	Mookherji, A. . . . .	543
Krishna Rao, J. . . . .	350	Mookherji, T. . . . .	543
Krishna Rao, J. S. R. . . . .	74, 409	M. R. A. (Rev.) . . . . .	87
Krishna Rao, K. V. . . . .	207	Mukherjee, S. L. . . . .	257, 454, 547
Krishnaswami, S. . . . .	220	Murthy, S. K. (Rev.) . . . . .	383
Krishnaswamy, N. R. . . . .	16	Murti, V. V. S. . . . .	297
K. R. (Rev.) . . . . .	384, 571	Murty, C. R. K. . . . .	254

	PAGE		PAGE
Murty, K. N. . . . .	21	Panikkar, N. K. . . . .	49
Murty, P. S. N. . . . .	73	Pant, D. D. . . . .	232, 280, 420, 559
		Pant, H. C. . . . .	73
NADAKAL, A. M. . . . .	220, 360	Panth, B. D. (Rev.) . . . .	203
Nagabhushanam, A. . . . .	21	Paracer, C. S. . . . .	328
Nagabhushanam, K. (Rev.) . . . .	187	Parameswaran, S. . . . .	103
Nagarajan, B. . . . .	8	Parikh, G. M. . . . .	208
Nagarajan, G. . . . .	64, 448	Parimoo, P. L. . . . .	66
Nagarajan, V. . . . .	116, 254	Parmar, R. . . . .	305
Nag Raj, T. R. . . . .	224	P. A. R. (Rev.) . . . .	91
Nagarkar, N. D. . . . .	534	Parshad, R. . . . .	255, 302
Naidu, A. S. . . . .	264	Patel, C. C. (Rev.) . . . .	284
Naidu, G. V. B. . . . .	425	Patel, H. K. . . . .	527
Naik, S. N. . . . .	405	Patel, M. K. . . . .	326
Nair, A. G. R. . . . .	115	Patel, R. C. . . . .	527
Nair, K. R. G. . . . .	368	Patel, V. C. . . . .	527
Nair, N. C. . . . .	322	Patell, J. . . . .	406
Nair, P. K. K. . . . .	566	Pathak, K. D. . . . .	404
Nair, V. J. . . . .	322	Pathki, K. G. . . . .	497
Narahari Rao, P. . . . .	142	Patil, B. D. . . . .	38
Narang, K. S. . . . .	545	Patil, S. V. . . . .	306
Narasimhamurthy, D. . . . .	505	Patnaik, K. K. (Miss) . . . .	279
Narasimhan, M. J. . . . .	564	Patnaik, M. M. . . . .	435
Narasimha Rao, P. . . . .	514	Pendse, G. S. . . . .	261
Narasinga Rao, A. . . . .	79	Pennidhana Rao, T. . . . .	348
Narayana, H. S. . . . .	184, 227	Perraju, A. . . . .	510
Narayana, L. L. . . . .	516	Perrur, N. G. . . . .	162
Narayanan, E. S. . . . .	348	Pisharoty, P. R. . . . .	54
Narayanan, P. K. . . . .	222	P. L. B. (Rev.) . . . .	569
Narayanan, U. H. . . . .	304	P. N. (Rev.) . . . .	188
Narayanamurthi, D. . . . .	73	Prabhakara Rao, M. V. . . . .	132
Narayanawamy, M. . . . .	308	Prabhu, K. A. . . . .	17
Nareish Chandra . . . . .	277	Prahlada Rao, L. S. . . . .	348
Nariani, T. K. . . . .	379	Prakasa Rao, P. S. . . . .	30
Narinder Singh . . . . .	235	Prakash Chandra . . . . .	34
Narula, P. N. . . . .	85	Prakash, U. . . . .	315
Natarajan, C. V. (Rev.) . . . .	90	Prasad, B. N. . . . .	272
Nautiyal, D. D. . . . .	232, 280, 559	Prasad, M. R. N. . . . .	155, 317
Nayar, P. G. . . . .	257	Prasad, S. S. . . . .	483, 517
Neogi, N. C. . . . .	19	Prasad, T. P. . . . .	67
Nirmala Chatterjee . . . . .	415	Prasada Rao, C. . . . .	505
Nirmal, H. B. . . . .	125	Prasannakumari, T. O. . . . .	460
Nirula, K. K. . . . .	221	Puntambekar, S. V. . . . .	310
Norula, J. L. . . . .	14, 111, 260	Pushpa Khanna . . . . .	133
N. S. N. (Rev.) . . . .	429		
PADHYA, A. C. . . . .	326	RACHIE, K. O. . . . .	321
Padhye, M. D. . . . .	373	Racine, C. (Rev.) . . . .	429, 476, 521
Padmanabhan, D. . . . .	573	Radhakrishnamurti, P. S. . . . .	546
Padmanabha Rao, T. V. . . . .	544	Radhakrishnan, M. . . . .	449
Paliwal, R. L. . . . .	128	Radhakrishnan, T. M. . . . .	490
Paliwal, Y. C. . . . .	379	Radhakrishnan, T. P. . . . .	450
Pancharatnam, S. (Rev.) . . . .	237	Radha Pant . . . . .	20
Pande, B. P. . . . .	273, 329	Radhakrishna Pillay, P. N. . . . .	428
Pandey, R. M. . . . .	83	Rafiq Siddiqi, M. . . . .	550
Pandhare, N. H. . . . .	356	— (Rev.) . . . .	479
Pandya, N. S. . . . .	542	Raghavan, K. . . . .	534
		Raghunath, T. . . . .	324, 368

	PAGE		PAGE
Raghuveer Rao, A. .. .. .	518	Samuel, C. T. .. .. .	413
Rai, J. N. .. .. .	135	Sankara Subramanian, S. .. .. .	12, 115, 308
Rai, V. K. .. .. .	31	Sankhla, H. C. .. .. .	420
Rajagopal, P. K. .. .. .	319	Santhamma, C. .. .. .	63
Ramachandra Rao, H. N. (Rev.) .. .. .	285	Saraiya, S. C. .. .. .	450
Ramachandra Row, L. .. .. .	67	Saraswathy Royan .. .. .	274
Ramachar, P. .. .. .	271	Sareen, M. L. .. .. .	24
Ramage, C. S. .. .. .	53	Sarma, K. G. .. .. .	453
Ramakrishna Murty, T. .. .. .	409	Sarma, P. S. .. .. .	153, 490
Ramakrishnan, T. S. .. .. .	428	— (Rev.) .. .. .	189, 569
Ramalingam, K. .. .. .	25	Sarojini, S. .. .. .	411
Raman, Sir C. V. .. .. .	1, 147, 245, 293, 341, 389, 437, 531	Sastri, M. N. .. .. .	67
Ramanathan, A. N. .. .. .	407	Sastry, K. S. M. .. .. .	519
Ramanathan, M. K. .. .. .	12	Sastry, M. S. .. .. .	71
Ramanujam, C. G. K. .. .. .	271, 327	Satpathy, K. C. .. .. .	305
Ramaseshan, S. .. .. .	248	Satya, H. N. .. .. .	518
Ramaswamy, C. .. .. .	95	Satyanarayana Reddy, A. .. .. .	510
Ramaswamy, M. K. .. .. .	13, 63, 107, 159, 249, 254, 351, 451, 497, 541	Satyanarayan, Y. .. .. .	507
Ramayya, N. .. .. .	27	Savithri, T. S. (Miss) .. .. .	407
Ramesh Dayal .. .. .	315	Saxena, M. N. .. .. .	358
Ranganathan, N. R. (Rev.) .. .. .	380	Saxena, S. K. .. .. .	22
Ranga Rao, K. .. .. .	213	Seerwani, A. B. .. .. .	182
Rangaswami, G. .. .. .	172, 223, 562	Seetharamiah, K. (Rev.) .. .. .	238
Rao, A. N. .. .. .	467	Senan, K. K. C. .. .. .	26
Rao, B. G. S. .. .. .	9	Sen Gupta, K. .. .. .	516
Rao, G. R. .. .. .	234	Sen, S. P. .. .. .	502
Rao, L. N. .. .. .	32	Seshachar, B. R. (Rev.) .. .. .	383
Rao, M. R. K. (Rev.) .. .. .	286	Seshadri, T. R. .. .. .	16, 151, 195, 251, 297, 453, 455, 499
Rao, M. V. .. .. .	182	Seshagiri Rao, T. .. .. .	373, 557
Rao, P. R. .. .. .	226	Seshavatham, V. .. .. .	443
Rao, R. P. .. .. .	21	Seth, B. R. .. .. .	492
Rao, R. S. .. .. .	386	Sethi, M. L. .. .. .	70
Rao, S. L. N. .. .. .	153	Sethi, S. L. .. .. .	511
Rao, V. G. .. .. .	84, 367	Shah, C. K. .. .. .	424
Rasheed, D. A. .. .. .	210	Shah, G. L. .. .. .	236
Rastogi, K. .. .. .	566	Shah, H. M. .. .. .	474
Rastogi, R. P. (Rev.) .. .. .	188	Shah, K. B. .. .. .	496
Rathore, Y. S. .. .. .	553	Shamim Jairajpuri, M. .. .. .	551
Rattan, R. S. .. .. .	567	Shankar, K. .. .. .	321
Ray Sarkar, B. C. .. .. .	418	Shant, B. K. P. S. .. .. .	545
Relwani, L. L. .. .. .	417, 441	Sharma, J. N. .. .. .	419
Rihani, G. D. .. .. .	158	Sharma, P. L. .. .. .	86
Roonwal, M. L. (Rev.) .. .. .	522	Sharma, S. K. .. .. .	107
Roy, D. N. .. .. .	116	Shenoy, S. B. R. .. .. .	304
Roy, N. K. .. .. .	503	Sherbet, G. V. .. .. .	166
SAGREIYA, K. P. (Rev.) .. .. .	480	Shinde, V. A. .. .. .	118
Sahai, B. N. .. .. .	500	Shri Ranjan .. .. .	83
Sahni, M. R. .. .. .	23, 77	Shrivastava, G. C. .. .. .	19
Sahni, V. P. .. .. .	276	Shroff, H. D. .. .. .	307
Sahoo, B. .. .. .	305	Siddiqi, A. H. .. .. .	318, 508
Saifi, A. Q. .. .. .	71	Siddiqi, M. Rafiq .. .. .	363, 414, 462
Salgar, S. S. .. .. .	18	Siddiqui, H. N. .. .. .	575
Sambamurty, P. .. .. .	350	Simha, Shyam Sunder .. .. .	551
Sampath Kumar, S. N. .. .. .	425	Singal, D. P. .. .. .	552
		Singhal, S. P. .. .. .	66
		Singh, D. P. .. .. .	419

	PAGE		PAGE
Singh, G. P. . . . .	81	Suryanarayana, K. V. . . . .	452
Singh, K. R. P. . . . .	116	Suryaprakasa Rao, A. . . . .	213
Singh, L. M. . . . .	209	Suryaprakash Rao, K. . . . .	461
Singh, M. . . . .	401	S. V. C. (Rev.) . . . . .	334, 382
Sinha, A. K. . . . .	135	Swaminathan, M. (Rev.) . . . . .	90, 140, 287, 478, 524
Sinha, B. D. . . . .	517	Swaminathan, M. S. . . . .	132, 539
Sinha, P. C. . . . .	500	Swami, U. B. S. . . . .	267
Sirsi, M. . . . .	455		
— (Rev.) . . . . .	42, 140, 477, 524, 570	TANDON, R. N. . . . .	35, 377, 462
Sivaramakrishnan, V. M. . . . .	8	Tandon, S. L. . . . .	234, 325
Smalley, I. J. . . . .	160	Tatwawadi, S. V. . . . .	69
— (Rev.) . . . . .	237	Thakar, G. P. . . . .	404
Smith, R. L. . . . .	162	Thomas, K. K. . . . .	127
Solomon Raju, N. . . . .	361	Thosar, B. V. . . . .	440
Somasekhara, S. . . . .	257, 454, 547	Thothathri, K. . . . .	178
Somayajulu, P. V. . . . .	504	Thyagarajan, B. S. (Rev.) . . . . .	88
Sood, B. S. . . . .	401	Tilak, S. T. . . . .	422
Sood, M. S. . . . .	195	Trivedi, J. M. . . . .	17
Soundar Raj, R. . . . .	363	Trivedi, J. P. . . . .	159
Sprague, E. W. . . . .	102	T. R. S. (Rev.) . . . . .	332
Sreenivasan, A. . . . .	130, 363	T. S. S. (Rev.) . . . . .	286
Sreenivasan, B. . . . .	208	Tulshyan, G. P. . . . .	374
Sreenivasaya, M. . . . .	11		
Sreeramulu, T. . . . .	173	UDUPA, K. N. . . . .	209
Sridharan, K. . . . .	115	Umapathy, P. . . . .	74
Sri Krishna, C. . . . .	67	Umamaheswara Rao, M. . . . .	173
Srimathi, R. A. . . . .	11	Upadhya, M. D. . . . .	427
Srinivasacharya, K. G. . . . .	63	Upadhyay, M. K. . . . .	134
Srinivasan, K. . . . .	36	Upadhyaya, V. N. . . . .	553
Srinivasan, K. S. . . . .	21	Upadhyaya, Y. M. . . . .	85
Srinivasan, K. S. . . . .	131	Urs, N. V. R. . . . .	445
Srinivasan, M. . . . .	21	Usgaonkar, R. N. . . . .	406
Srinivasan, V. V. . . . .	211	Usha Bijal, . . . . .	186
Srinivasa Rao, S. . . . .	262	Usman, S. . . . .	563
Srivastava, H. P. . . . .	558		
Srivastava, M. P. . . . .	35, 426	VAIDYANADHAN, R. . . . .	119, 312
Srivastava, P. N. . . . .	272	Vaidya, P. C. (Rev.) . . . . .	568
Srivastava, R. D. . . . .	17	Vaidya, S. M. . . . .	102, 128
Srivastava, R. K. . . . .	19	Vani, R. S. . . . .	493
Srivastava, R. M. . . . .	114	Varghese, T. M. . . . .	423
Subba Rao, B. C. . . . .	404	Varma, C. P. . . . .	21, 75
Subrahmanyam, C. B. . . . .	165	Varughese, P. A. . . . .	386
Subrahmanyam, S. V. . . . .	110	Vasant Gurunath Rao . . . . .	473
Subrahmanyam, R. . . . .	441	Vasantha, T. V. . . . .	214
— (Rev.) . . . . .	335, 347, 478	Vasishtha, K. (Miss) . . . . .	499
Subramanian, C. V. (Rev.) . . . . .	523	Vasudeva, R. S. . . . .	136
Subramanian, G. B. V. . . . .	151	Venkataraman, G. S. . . . .	366, 402
Subramaniam, M. K. . . . .	169, 274, 364, 465	Venkataramani, B. . . . .	302
Subramaniam, T. V. . . . .	564	Venkateswarlu, J. . . . .	9, 345, 443, 514, 544
Subramoney, N. . . . .	512	Verghese, J. . . . .	259
Sugathan, K. K. . . . .	259	Verma, R. P. . . . .	483
Sukumaran, K. K. . . . .	103	Verma, S. C. L. . . . .	118
Sundararajan, K. . . . .	304	Vidwans, D. B. . . . .	72
Sundararajulu, G. . . . .	412	Vig, B. K. . . . .	375
Sundaram, A. K. . . . .	450	Vijayavargiya, R. . . . .	71
Sundara Rao, W. V. B. . . . .	366	Vishnu Swarup . . . . .	419
Surendranath, M. . . . .	69		

	PAGE		PAGE
Viswanathan, K. S. (Rev.)	332	WADHW, B. M.	482
Viswanathan, S.	120, 360	Wiebe, H. H.	162
Viswanathiah, M. N.	410		
V. J. (Rev.)	189	YAZDANI, G. M.	413
Vohra, J. N.	482		

## Subject Index

	PAGE		PAGE
ACTION of Sodium Borohydride-Lewis Acid Complexes on Acetals and Ketals	404	Anilocra, Nature of Protein of Exocuticle of	320
Activation of Microwave Crystal at Low Input Powers	255	Annual Reproductive Cycle of the Prawn <i>Penaeus indicus</i>	165
Acuity, Visual, and Its Variations	531	Antagonistic Effect of <i>B. subtilis</i> on <i>Azotobacter vinelandii</i>	81
Adamantane and Its Homologues	485	Antarctic Krill, Natural History and Geography of, (Rev.)	347
Additions to the Fungi of India	175	Anthelmintic Principle of the Seeds of <i>Butea frondosa</i>	456
Adiabatic Compressibility of Lithium Nitrate Solution	110	Aquatic Angiosperms (Rev.)	336
Adrenocorticotrophic Hormone (ACTH), Synthesis of	576	<i>Arachis hypogaea</i> —A Host of Southern Sannhemp Mosaic Virus	379
Advanced Materials (Rev.)	521	<i>Areca catechu</i> Linn., Pharmacology of	455
Advances in Agronomy (Rev.)	571	Asafoetida, Sex Regulating Property of, in Cucurbits	136
— — Clinical Chemistry (Rev.)	140, 477	Ascigerous Mould, A New Record from India	177
— — Ecological Research (Rev.)	480	Asclepiadaceae and Periplocaceae of Bombay (Rev.)	384
— — Electrochemistry (Rev.)	430	Association of a New Species of <i>Phoma</i> with <i>Pleospora herbarum</i> (Pers.) Rahb.	174
— — Food Research (Rev.)	287	<i>Ateleopus</i> , Occurrence of Deep Water Teleost	413
— — Insect Physiology (Rev.)	522	Atomic Physics (Rev.)	40
— — X-Ray Analysis (Rev.)	333	<i>Aulosira fertilissima</i> , Effect of Inoculation of, on Rice Plants	366
Agrillisation and Wallrock Alteration at Mosabboni Copper Mines	356	Award of Research Degrees 45, 92, 142, 192, 289, 337, 386, 434, 482, 527, 574	
Air Pollution (Rev.)	203	Awning in Rice, Twin and Forked	142
<i>Ajuain</i> , <i>Trachyspermum ammi</i> , Results of Breeding, for Essential Oil Content	371	<i>Azotobacter chroococcum</i> , Incidence of, in Laccadive Islands Soils	512
Aldehydes as Corrosion Inhibitors	256		
Algæ (Rev.)	42	BACTERIA (Rev.)	140, 522
Alkali Halides, Infra-Red Behaviour of	1	Bacterial Leaf Blight of Castor Beans	474
<i>Alternaria</i> Blight of <i>Celosia cristata</i> , a New	84	— Leaf-Spot on <i>Corchorus acutangulus</i>	326
Amino-Acids in <i>Areca catechu</i>	548	Basal Rot of Onion	420
— — Tamarind Seeds	279	<i>Belonolaimus hastulatus</i> and <i>Tylenchoderhynchus indicus</i> , Identity of	550
— — the Chick Organizer Region	166	Beryllium Oxide, Determination of, by Homogeneous Precipitation	67
Amperometric Determination of Gold with Thiourea	69	Bibliography of Indian Zoology	482
Amplitudes of Vibration of XY <sub>2</sub> Type Ions from Raman Data	448	Biochemical Basis for the Food Preference of the Predator <i>Coccinella</i>	511
<i>Amsacta moorei</i> , Gujarat Hairy Caterpillar, Control of, by Tilodrin	527	Biology of Cilia and Flagella (Rev.)	431
Analysis of Saint Venant Torsion for Regular Polygonal Cross-Sections	395	Birbal Sahni Institute of Palaeobotany	527
Anatomical Structure of the Pinnæ of <i>Cycas</i>	232		
Androgenic Hormone and Testosterone Propionate, Comparison of Effects of, on Female Ocypod Crab	411		
Anhydrous Hydrazine	291		

	PAGE		PAGE
Blennioid Fish, <i>Petrosirtes kochi</i> , A		Chromosome Number of <i>Uræotyphlus</i>	
New Record of .. .. .	413	<i>menoni</i> .. .. .	274
Blight of <i>Peucedanum graveolens</i> ..	324	— Numbers in Some Grasses ..	267
Blood Vessels and Lymphatics (Rev.)	90	Chromic Acid Oxidation of Secondary	
Blue-Green Algæ, Role of, on Paddy		Alcohols, An 'E <sub>2</sub> ' Mechanism for ..	546
Yield .. .. .	417	Clavariaceæ of India (Rev.) ..	523
— — — Chemical Nutrients and		Cobalt-60, Uptake and Binding of, by	
Partial Soil Sterilization on Paddy		Rat Skin .. .. .	8
Yield .. .. .	441	Coconut, Nectar in, Sugar Composition of	460
Bombay Rats, Studies on .. .. .	163	Coexisting Pyroxene and Amphibole	
Books Received 44, 91, 141, 191, 239, 288,		in Alkali-Gabbro .. .. .	549
336, 385, 433, 480, 526, 573		Coherently Driven Molecular Vibrations	
Boron Trifluoride, Studies in Reactions		and Light Modulation .. .. .	447
of .. .. .	544	Colchicine, Effect of, on the Growth of	
Britain's First University Reactor ..	338	<i>Alternaria tennis</i> .. .. .	135
Bubble Chamber, 80-Inch Hydrogen ..	528	Collateral Host Plants of Root-Knot	
<i>Butea frondosa</i> , Anthelmintic Principle		Nematodes .. .. .	221
of Seeds of .. .. .	456	Collected Works of John von Newmann	
		(Rev.) .. .. .	381
CARBONACEOUS Meteorites, Microstruc-		Collection of Problems in Physical	
tures in .. .. .	47	Chemistry (Rev.) .. .. .	188
Carbon Tetraiodide, Thermodynamic		College Botany (Rev.) .. .. .	43
Properties of .. .. .	449	Colloids in Clarified Cane Juices ..	17
Catalase Activity and Iron Deficiency		Colours of Gemstones .. .. .	437
in Soybean Leaf Tissue .. .. .	162	Commemoration Volume (K. Venkata-	
Catalysis, Third International Congress	240	raman) (Rev.) .. .. .	332
Caterpillar Pest of Jowar Earheads, A		Comparative Biochemistry (Rev.) ..	569
New .. .. .	563	— Nutrition of Man and Domestic	
Cell Divisions in <i>Ricinus communis</i>		Animals (Rev.) .. .. .	524
Endosperm .. .. .	28	Complex Numbers and Functions (Rev.)	521
— Mechanisms in Hormone Production		Comprehensive Chemistry (Rev.) ..	382
and Release (Rev.) .. .. .	42	Conference on "Luminescence" ..	574
<i>Celosterna scabrator</i> , New Host Plant		Congress in Honour of Archimedes ..	337
of .. .. .	434	Conservation of Vector Current in Weak	
Ceramic Photon Counters .. .. .	143	Interactions .. .. .	242
<i>Cercospora ocimicola</i> , Occurrence of, in		Continuum Mechanics, Symposium on	492
India .. .. .	283	Copper and Manganese Contents of	
Cerebral Sphingolipidoses (Rev.) ..	42	Forage Plants .. .. .	507
Changes in Earth's Magnetic Poles ..	576	— in Gomoh-Topchanchi Area (Bihar)	435
Characterisation of Indoles .. .. .	18	— Minerals in the Gneisses and	
Chemical Carcinogenesis (Rev.) ..	239	Granulites of Visakhapatnam ..	409
— Examination of <i>Canarium bengalense</i>	162	Correspondence of Isaac Newton (III)	
— Extractives of the Heartwood of		(Rev.) .. .. .	380
<i>Shorea robusta</i> .. .. .	544	Cow Milk, Detection of Buffalo Milk in,	
— Investigations of <i>Lantana camara</i>	71	by Spectrophotometric Method ..	503
Chilli—A New Host Plant of <i>Heliothis</i>		<i>Criconea serratum</i> , A Parasite on	
<i>armigera</i> .. .. .	464	Peach Trees .. .. .	414
Chloride Regulation in <i>Marphysa</i>		<i>Crossosoma californicum</i> , Embryology	
<i>gravellyi</i> Southern .. .. .	463	and Systematic Position of ..	493
Chlorophyll Mutants in <i>Pennisetum</i>		<i>Crotalaria spectabilis</i> —A New Green	
<i>typhoideum</i> Induced by $\gamma$ -Rays ..	179	Manuring Crop .. .. .	268
Chromatography, A Modified Technique		Crystal Structure of Ba(OH) <sub>2</sub> , 8H <sub>2</sub> O	
for Separation of Amino-Acids ..	118	and the Crystal Co-ordination of the	
Chromographic Contact Prints for		Barium Ion .. .. .	248
Gold .. .. .	79	<i>Culicoides</i> , Aberrant Forms in Two	
Chromosome Number of <i>Cyamopsis</i>		Species of, .. .. .	218
<i>serrata</i> .. .. .	427		



	PAGE		PAGE
Cultivated Plants and Their Wild Relatives .. .. .	291	"Discovery" to Join the Indian Ocean Expedition .. .. .	92
<i>Curvularia</i> , A New Species of, on the Leaves of <i>Carica papaya</i> .. .. .	558	Dispersion Relations and the Abstract Approach to Field Theory (Rev.) .. .. .	40
— <i>spicifera</i> , Occurrence of, on .. .. .	517	Double Hyper-Fragment .. .. .	387
<i>Celosia cristata</i> .. .. .	517	— Top Cross-Maize Hybrids .. .. .	513
— <i>verruciformis</i> , A New Fungus .. .. .	276	Drifting Continent .. .. .	388
Cuticular Sheath in <i>Euderus agromyzæ</i> Embryo .. .. .	331	Drop Recording Device for Pharmacological Experiments .. .. .	19
Cyanomacurin, Structure of .. .. .	251	Duplex Origin of Petroleum .. .. .	394
Cyclic Organopolysilanes .. .. .	530		
Cyclohexane Diamine Tetraacetic Acid Complexes .. .. .	450	EARTH'S Magnetic Poles, Changes in Effect of Fungicides on Pectolytic Enzyme Activity of Fungi .. .. .	576
<i>Cyperus papyrus</i> , A New Record for India .. .. .	424	.. .. .	398
Cytological Studies in the Endosperm of <i>Nothoscordum fragrans</i> .. .. .	325	Egg Capsules of the Snail <i>Ariophanta ligulata</i> .. .. .	213
Cytology in the Genus <i>Tephrosia</i> Pers. — of <i>Nicandra physaloides</i> Gaertn. .. .. .	345 9	<i>Emeria battakhi</i> from Domestic Duck — <i>rajasthani</i> from Indian Camel .. .. .	329 273
DALBERGENONE from the Heartwood of <i>Dalbergia sissoo</i> .. .. .	455	Elastic Constants of Volcanic Rocks from Japan .. .. .	213
Debye-Huckel Limiting Law for the Activity Coefficients of Strong Electrolytes .. .. .	65	Electrochemistry, Fourth Seminar .. .. .	530
Degradation of Hard Resin from Lac Dehydrated Castor Oil, Evaluation of Total Unsaturation in .. .. .	151 310	Electromagnetic Waves in Stratified Media (Rev.) .. .. .	334
— Potato, Storage Stability of .. .. .	311	Electromagnetism, Theoretical (Rev.) .. .. .	40
Dekatron Scaler, A Simple Timer .. .. .	304	Electron Microscopy, Techniques for (Rev.) .. .. .	41
<i>Dendrographium</i> , A New Species of, from India .. .. .	473	Electron-Pair Interpretation of the Pion Interaction and the Structure of Heavy Mesons .. .. .	61
Desalting Sea-Water .. .. .	530	Elementary Zoology (Rev.) .. .. .	91
Development in Applied Spectroscopy (Rev.) .. .. .	138	Elements of Indian Stratigraphy (Rev.) .. .. .	90
— of Stomata in <i>Psilotum nudum</i> .. .. .	420	<i>Eleusine coracana</i> , African Origin of Embryo Development in <i>Passiflora foetida</i> .. .. .	300 373
Diagnosis of Mineral Deficiencies in Plants (Rev.) .. .. .	286	Embryological Observations of <i>Guiera senegalensis</i> .. .. .	30
Diamagnetic Anisotropy of Pyridine and the Susceptibilities of Dihydro- and Tetrahydro-Pyridines .. .. .	497	Embryology of a Few Rutaceæ .. .. .	516
Diamond Pressure Cell for High Pressure Optical Studies .. .. .	144	— — <i>Erythrina indica</i> .. .. .	229
Diamonds, Artificial, New Process for Making .. .. .	47	Endogenous Flowers in <i>Carica papaya</i> .. .. .	131
<i>Didymodon obtusifolius</i> , Name Change for .. .. .	482	Endosperm in Euphorbiaceæ and Occurrence of Endosperm Haustoria in <i>Croton</i> .. .. .	514
Differential Crossability of Maize Strains with <i>Tripsacum</i> .. .. .	202	Energy of the Schwarzschild Exterior Field .. .. .	496
— Thermal Analysis of Opal .. .. .	387	— Spectra of Odd-Mass Nuclei, Empirical Regularity in .. .. .	497
Dihydroxy-Naphthalene Sulphonic Acid as Analytical Reagent for Zirconium .. .. .	306	Engineering Thermodynamics (Rev.) .. .. .	286
<i>Diocalandra stigmaticollis</i> , New Borer Pest of Arecanut .. .. .	425	Entomogenous Bacteria, A New .. .. .	553
Diploid <i>Parthenium</i> in Jammu .. .. .	273, 386	Enzymatic Softening of Wood .. .. .	73
Dipole Moments of Dyes .. .. .	356	Enzyme Histochemistry and Its Applications in the Study of Neoplasms (Rev.) .. .. .	477
Directory of British Scientists (Rev.) .. .. .	479	Enzymes (Rev.) .. .. .	189
		Epidermal Structure of Pinnæ of <i>Macrozamia</i> .. .. .	280
		— — — the Sporangia of Cycads .. .. .	559

	PAGE		PAGE
Epidermal Studies on Some Species of <i>Eragrostis</i> .. .. .	269	Fungi-Toxicity of Extracts from Tannin-Bearing Plants .. .. .	226
Erythrocytic Glucose-6-Phosphate Dehydrogenase in Various Animal Species .. .. .	405	Fusarium Rot of <i>Gladiolus</i> .. .. .	377
E <sub>g</sub> -Transitions in Rare-Earth Nuclei, K-Conversion Coefficients of .. .. .	451	— <i>semitectum</i> on <i>Anona squamosa</i> , A New Host Record .. .. .	483
Europium Orthosilicate, A New Transparent Ferromagnet .. .. .	528	GALLENKAMP Technico House .. .. .	400
Even-Even Nuclei, Note on 5-Levels .. .. .	63	Gametophytes of <i>Lygodium circinatum</i> and <i>L. flexuosum</i> .. .. .	34
<i>Exosporium ampullaceum</i> , A New Record for India .. .. .	518	Gamma-Rays Following the Decay of 3-Hour Ti <sup>45</sup> .. .. .	13
Exploring Inner Space .. .. .	56	Gas Chromatography (Rev.) .. .. .	284
Extracarpellary Ovules in Some Ranales .. .. .	230	Gemstones, Colours of .. .. .	437
Extreme High Vacuum Chamber .. .. .	93	Genetics of Seedling Resistance to Race 122 of Black Rust of Wheat .. .. .	182
FELSPARS in Anjana Gneisses .. .. .	504	Genetic Transformations with DNA .. .. .	242
Ferric Chloride Method for Determination of Serum Total Cholesterol .. .. .	407	Geology of Kannegiri Hills, Andhra Pradesh .. .. .	461
Fields and Circuits in Electrical Machines (Rev.) .. .. .	285	— — the Area Around Pinjaur .. .. .	23
Fish and Fisheries (Wealth of India) (Rev.) .. .. .	44	Geometrodynamics (Rev.) .. .. .	568
— as Food (Rev.) .. .. .	526	Geophysical Symposium .. .. .	527
— Eggs off Waltair Coast .. .. .	361	<i>Glossopteris</i> Fructifications from Chintalput Sandstone .. .. .	75
— in Nutrition (Rev.) .. .. .	90	Glutethimide, Effects of, on Enzyme Systems .. .. .	71
5-Methoxy Flavan-4-Ols, A Special Characteristic of .. .. .	453	Grain Sizes of the Constituents in Limestone .. .. .	207
Flavonoids and Cold Injury .. .. .	12	Gravel Indications of Former Drainage in Nellore Area .. .. .	312
— of the Flowers <i>Guazuma tomentosa</i> .. .. .	308	Gravimetric Determination of Zirconium .. .. .	66
Floral Abnormality in Cotton .. .. .	33	Gravitational Waves, Type-N in Non-Empty Space-Time .. .. .	350
— Anatomy of <i>Monsonia senegalensis</i> .. .. .	184	Green Colour of Vegetation .. .. .	341
— Colours and Their Spectral Composition .. .. .	147	Growth of <i>Albugo</i> in the Callus Culture of <i>Ipomoea</i> .. .. .	472
— — — the Physiology of Vision .. .. .	293	— Spirals on Zinc Single Crystals .. .. .	542
— morphogenesis in Rice Plant .. .. .	554	<i>Habenaria viridiflora</i> , from Assam (A Correction) .. .. .	193
— Morphology of <i>Bœrhavia verticillata</i> .. .. .	322	Hæmatoxylin Squash Technique for the Study of Grasshopper Chromosomes .. .. .	364
Fluid Mechanics (Rev.) .. .. .	238	Halogenation of Disulphides in Water .. .. .	208
Fluorspar in Kerala State .. .. .	386	H-Alpha Line in the Solar Flare of November 12, 1960 .. .. .	106
Foraminifera in Cretaceous Rocks, Occurrence of .. .. .	210	Hamycin—A New Antibiotic .. .. .	483
Fossil Particle Tracks in Natural Micas — Wood Resembling <i>Grewia</i> .. .. .	48	Handbuch Der Kolorimetric (Rev.) .. .. .	137
Fossils, Oldest .. .. .	93	<i>Hansfordiella</i> , A New, from India .. .. .	518
Free Amino-Acid Content in the Central Nervous System of Freshwater Crab. — Amino-Acids in a Digenetic Trematoda .. .. .	125	<i>Helicomina poonensis</i> from India .. .. .	368
— — — of Some Insect Tissue Homogenates .. .. .	552	Helminths from an Indian Hyæna .. .. .	511
Frequency of Trivalents in Autotetraploid Guar .. .. .	20	<i>Heterosporium</i> , A New Species of .. .. .	422
Functional Male-Sterility in <i>Brassica campestris</i> .. .. .	375	<i>Heterothrix ulotrichoides</i> Pascher in India .. .. .	272
Fungi from Mysore, New Records of .. .. .	370	Histochemical Demonstration of Alkaline Phosphatase in <i>Candida</i> .. .. .	408
	224	Histochemistry of Yolk Nucleus in <i>Lycosa chaperi</i> .. .. .	24
		History of Science Unit, C.S.I.R. .. .. .	192

	PAGE		PAGE
Human Nutrition and Dietetics (Rev.)	478	Internal Conversion; Review of Recent Results on	249
Hydraulics (Rev.)	286	International Botanical Congress (Tenth)	386
Hydrocyanic Acid Content of <i>Sorghum</i>	223	— Conference on Cosmic Rays	434
Hydrodynamic Superposability (Rev.)	569	— — — Role of Atomic Electrons in Nuclear Transformations	440
Hydrogen Bonding Energies in <i>p</i> -Bromophenol and <i>o</i> -Hydroxy Biphenyl	112	— Review of Cytology (Vols. 13 and 14) (Rev.)	478
Hydrogen-Ion Concentration, Influence of, on the Utilization of Sodium Nitrite by <i>Diplodia typhina</i>	35	— — — Experimental Pathology (Rev.)	570
Hypothesis of Earth's Behaviour	435	— Union of Testing and Research Laboratories	46
		— Year of the Quiet Sun	46
IDAITE, A New Copper Sulphide from Nellore District	74	Interplanetary Magnetic Fields and Comet Tails	484
Impermeability to Colour Pigments in a Polyvoltine Strain of <i>Bombyx mori</i>	220	Interpretation of Ultrastructure (Rev.)	383
Indian Academy of Sciences, XXVIII Annual Meeting	6	Intracellular Localisation and Biosynthesis of Catalase in Liver Tissue	490
— Beetles to Destroy Australian Plant Pest	484	Intramarginal Tracheids in <i>Anticharis linearis</i>	423
— Journal of Pharmacy	92	Introduction to Elementary Particles (Rev.)	187
— Languages, Relative Efficiencies of, from Information Theory (Rev.)	432	— — Mathematical Machine Theory (Rev.)	139
— Livestock (Rev.)	290	— — Nonlinear Differential and Integral Equations (Rev.)	238
— Ocean Expedition	49	— — the Chemistry of Complex Compounds (Rev.)	284
— Pharmaceutical Congress Association	337	— — Theoretical Physical Chemistry (Rev.)	87
— Science News Association	574	Introductory Organic Quantum Chemistry (Rev.)	88
Indoles, Characterisation of	18	Inverse Thermo-Remanent Magnetization	242
Induced Spawning of the Chinese Carps in Ponds	103	— Activity in Midgut and Cæca Tissue in <i>Locusta migratoria</i>	169
— Sphærococcoid Mutations in <i>Triticum aestivum</i>	539	Ionospheric Consequences of the Earth's Orbital Eccentricity	240
— Tetraploidy in <i>Asclepias curassavica</i>	376	— Top-Side Sounder	193
Inductance Calculations (Rev.)	238	<i>Ipomoea</i> , Growth of Albugo in the Callus Culture of	472
Induction of Flowering in Trailing Shoots of <i>Saccharum spontaneum</i>	36	Isoflavones, Reduction of, with Sodium Borohydride	67
Infra-Red Behaviour of the Alkali Halides	1	Isomerisation of Optically Active Ethers	14
Inheritance of Seed Characters in Broad Beans	93	Isonitroso Derivatives of Malon-Mono Arylamides	66
— — Stem and Glume Discolouration in Wheat	85		
Insect Parasites of Live-Stock and Their Control (Rev.)	191	<i>Jatropha curcas</i> , A Collateral Host for <i>Oidium havea</i>	428
— Pathology (Rev.)	335	Journal of Applied Probability	527
Institute of Physics and Physical Society	142	— — Scientific and Industrial Research	243
— — — — — Conferences	45	Jujubes, Cytology of	235
— — — — — Exhibition	434	<i>Jussieua</i> and <i>Ludwigia</i> , Study of the Pollen Grains of	443
Institution of Chemists (India)	192		
Interaction Between the Atmosphere and the Oceans	95		
Interchromosome Distribution of Chiasmata in Annual Chrysanthemum	369		
Interfacial Phenomena (Rev.)	572		
Interference Fringes by Independent Master Beams	339		
Interferon, New Role for	529		
		KHONDALITE, Occurrence of, from Chor Area, Himachal Pradesh	358

	PAGE		PAGE
Kinetin-Regulated Protein Level in		Lyman- $\alpha$ Detector .. ..	337
Isolated Tobacco Leaf .. ..	470	<i>Lyngbya majuscula</i> Harvey ex Gomont,	
Kneeing Habit in Rice .. ..	222	Structure of the Sheath in .. ..	402
LABORATORY Organization and Admin-		Lysozyme, Structure of .. ..	144
istration (Rev.) .. ..	431		
Lac, Hard Resin from .. ..	151	MAGMATIC Ore Solution, "Active" ..	387
Lachrymatory Factor in Onion ..	436	Magnetic Behaviour of Rare-Earth Ions	
<i>Laccifer lacca</i> , Chromosome Number		in Solution .. ..	543
and Spermatogenesis in .. ..	374	— Susceptibilities of Rocks .. ..	499
Lady Tata Memorial Trust Scholar-		Magnetism and Molecular Structure:	
ships .. ..	45, 289	Monosubstituted Phenols and Their	
Large Angle Rayleigh Scattering of		Esters .. ..	161
662 keV. Gamma Rays .. ..	401	Maize Hybrids, New Sweet, for the	
Lasers, New Technique for Preparing		Northern Plains .. ..	102
Lateral Roots in <i>Phaseolus mungo</i> ,		Maize Strains, Crossability with <i>Trip-</i>	
Effect of Auxin on the Emergence of	31	<i>sacum</i> .. ..	202
<i>Lathyrus sativus</i> Seeds, Structural		Male Gametophyte and Obturator in	
Features and Neurotoxic Action of a		<i>Cyperus rotundus</i> .. ..	133
Compound from .. ..	153	— — of <i>Viola odorata</i> .. ..	183
Lattice Parameters of Brasses, Accurate		Man-Made Radiation Belt, Radio	
Evaluation of .. ..	262	Measurements of .. ..	241
Leaf Development in Palms .. ..	537	Many-Body Problem (Rev.) .. ..	139
Leaf-Spot of Apple Blossom .. ..	177	Marine Cercariæ and Their Gastropod	
Leguminosæ, Studies in .. ..	178	Hosts .. ..	25
<i>Lennea coromandelica</i> , Chemical Exami-		<i>Marphysa graveleyi</i> , Chloride Regula-	
nation of the Flowers of .. ..	115	tion in .. ..	463
Lepidomysidæ, Discovery of Primitive		Mars Probe, Data from .. ..	94
Mysidacean Family, in India ..	219	<i>Martesia fragilis</i> , Distribution of Glyco-	
L-Forbidden Transitions Near Deformed		gen in .. ..	211
Region .. ..	254	Mathematics in Science and Engineering	
<i>Licea</i> , Isolation of a Species of ..	38	(Rev.) .. ..	429
Lifetime of the 70 Kev. Level in Sb-121		Matrix Computer .. ..	289
— Studies in Tellurium-121 .. ..	159	Mean Amplitudes of Vibration for	
Lignans, Synthesis of a Tetralone		Molybdenum and Rhenium Hexa-	
Related to Sikkimotoxin .. ..	307	fluorides .. ..	64
Likelihood Ratio Criterion Test Proce-		Measurement of Radiation and Heat	
dure, Optimal Properties of .. ..	452	Balance over the Indian Ocean ..	55
Lime with Fertiliser Mixture, Increase		Meiotic Studies in <i>Bærhavia repanda</i>	234
in Legumes Yield .. ..	26	— — — Some Members of the Tube	
Linear Polarization of Radio Waves		Panicæ .. ..	180
from Saturn .. ..	157	<i>Meloidogyne</i> , Infecting Certain Plants	
Liquid Rockets and Propellants (Rev.)	188	in Kerala .. ..	360
<i>Lobelia chinensis</i> from Bombay ..	236	— <i>javanica</i> , On Egg Number and Size	
Location of the Gene for Leaf Margin		Produced by .. ..	562
Dentness in Barley .. ..	134	Mendelevium, Production of .. ..	47
Lodging Index for Use of Maize		Mercurimetric Determination of Chloride	
Breeders .. ..	128	and Bromide Ions, $\alpha$ -Nitroso- $\beta$ -	
<i>Longidorella xenura</i> (Nematoda:		Naphthol as Indicator in .. ..	306
Dorylaimoidea), Around Apricot Roots	363	Methods of Experimental Physics (Rev.)	525
Long Wavelength $\pi$ - $\pi^*$ Transition in Di-		Micro-Aerosols (Rev.) .. ..	524
chloro Benzaldehydes .. ..	63	Microbiology and World Food-Supplies	299
Lorenz Curve of Concentration, Geo-		Micro-organisms in Artesian Well	
metry of .. ..	350	Water .. ..	172
Lunik-IV, USSR Rocket to Moon ..	194	—, Large-Scale Breeding of .. ..	143
<i>Lycoperdon pusillum</i> , A New Record in		Microwave Circuit Theory and Analysis	
Indian Gasteromycetes .. ..	282	(Rev.) .. ..	381

	PAGE		PAGE
Microwave Crystals as Thermometers in		OCCURRENCE of <i>Enteromorpha</i> at Khar-	
Low Temperature Range .. ..	302	gone (M.P.) .. ..	182
Mineral Metabolism (Rev.) .. ..	89, 238	— — Ostracoda in the Upper Cretaceous	
Miniaturization for Plant Life ..	46	Rocks of South India .. ..	434
Mixing Ratios ( $M_1-E_2$ ) in Some Even-		Ocean-Waves .. ..	54
Even Nuclei .. ..	351	<i>Odontotermes obesus</i> as a Pest of	
Modern Multidimensional Calculus		Japanese Mint .. ..	193
(Rev.) .. ..	476	On Growth and Form (Rev.) .. ..	383
— Operational Calculus (Rev.) ..	238	Onion Smut, Present Status of, in India	445
Molecular Genetics (Rev.) ..	523	Orbital Capture, Recent Results in ..	541
— Physics—Summer School on (1964)	576	Ordinary Differential Equations (Rev.)	476
Morphogenesis of the Pedal Gland in		Organic, Inorganic and Physical Che-	
<i>Achatina fulica</i> .. ..	167	mistry (Rev.) .. ..	571
Movement of Fin and Blue Whales		Oriented Crystal Growth in Aluminium	
(Rev.) .. ..	335	Films .. ..	107
Mulberry Seeds, Response of, to Gibber-		Origin of the Earth's Magnetic Field	289
rellic Acid .. ..	348	Operational Research Society of India	192
Muscle Receptors, Symposium on (Rev.)	287	<i>Ophiobolus graminis</i> , Occurrence of, in	
Myriconol from the Stem-Bark of		India .. ..	282
<i>Myrica nagi</i> .. ..	16	Optical Transistor .. ..	241
<i>Myrothecium</i> Rot of Tomato ..	426	Oscillations in Magnetostriction ..	483
		Ovule Characters in the Systematics of	
NATIONAL Chemical Laboratory, Poona,		Gramineæ .. ..	277
Report .. ..	290	Oxine Derivatives .. ..	302
Native Sulphur in Recent Sediments		Oxygenases (Rev.) .. ..	189
from the Godavari Delta Basin ..	264	Oxygen Uptake of <i>Pleurobrachia globosa</i>	319
Natural Gas and Methane Sources		PACHMARHI Formation, Stratigraphy of	22
(Rev.) .. ..	335	Palæontology and Stratigraphy of the	
— Triploid in Brinjal .. ..	92	Jabalpur Series .. ..	411
Naturally Occurring Anhydrovitamin A <sub>2</sub>	257	Paleocene and Eocene Beds in the	
Nature of Contact between the Lower		Barmer District .. ..	575
and the Upper Murrees in Jammu	359	Palms, Leaf Development in ..	537
Nemosecretory Release in Cockroach by		<i>Panulirus polyphagus</i> , Branched Oviduct	
Vital Staining .. ..	127	in .. ..	35
Neurolythirism in Chicks, Production		Papaya Decline Disease Incited by	
of, by <i>L. sativus</i> Injection ..	116	Nematodes .. ..	564
Nitrogen in the Tropics (Rev.) ..	384	Pearl Millet Germplasm, Variability in	321
Non-Ejaculated Spermatozoa in the		Pectolytic Activity of a Sewage	
Epididymis of <i>Anser melanotus</i> ..	265	<i>Epistylis</i> sp. .. ..	459
Non-Metallic Reactor Fuels ..	338	Perhydro Thiazino- and Thiazolo-	
Nourishment of the Growing Oocytes of		Benzimidazoles .. ..	454
the Frog and the DNA Content ..	415	Peroxide as Dehydrohalogenating Agents	545
N. Q. R. Zeeman Spectrum of 2, 5-		Persisting Nucleoli and Micronuclei in	
Dichloro-nitrobenzene .. ..	254	the Mitotic Cells of <i>Pisum sativum</i> ..	169
Nuclear Explosion, Geomagnetic Distur-		<i>Petroscirtes kochi</i> , from Andamans ..	413
bances of .. ..	47	<i>Pholadomya</i> , Occurrence of Two Species	
— Graphite (Rev.) .. ..	431	of, in Madhya Pradesh .. ..	506
— Transformations, Role of Atomic		<i>Phomopsis</i> , A New Species from	
Electrons .. ..	440	Jabalpur .. ..	279
Nucleic Acid Levels in Mineral Deficient		Photodynamically Active Plant Pro-	
Plants .. ..	83	ducts .. ..	195
Nucleolus—Satellite Relationship in		<i>Phyllosticta</i> , A New Species of ..	129
<i>Cicer arietinum</i> .. ..	465	Physical Chemistry of Metallurgical	
Numerical Solutions of Differential		Processes (Rev.) .. ..	88
Equations (Rev.) .. ..	429	— Methods in Heterocyclic Chemistry	
Nutritional Biochemistry (Rev.) ..	570	(Rev.) .. ..	476

	PAGE		PAGE
Physical Properties of Heavy Oxygen Water .. .. .	194	Prothoracic Sclerites in <i>Dysdercus kaenigii</i> , Development of .. ..	216
Physics of Rain Clouds (Rev.) .. ..	237	<i>Psilenchus neoformis</i> (Nematoda: Tylenchida) .. .. .	318
— — the Nucleus (Rev.) .. .. .	187	Pulse Circuits (Rev.) .. .. .	429
Physiology of Reproduction, Training Programme in .. .. .	155	Pulse-Sine Wave Converter .. ..	108
— — Vision, Floral Colours and .. ..	293	Pyrodynamics, New Quarterly Journal .. ..	482
Phytochemical Studies on <i>Crotalaria</i> .. .. .	70	QUANTUM Theory (Rev.) .. .. .	332
Phytopathological Society of India .. ..	142	Quartz, On the Regularity of the Tetrahedra in .. .. .	349
Phytosterol: $\beta$ -Sitosterol from <i>Boswellia serrata</i> .. .. .	324	Quinazolinones, Direct Sulphonation of .. .. .	547
Pigmentation of <i>Pallisantes</i> , an Intestinal Parasite of <i>Ophiocephalus</i> .. ..	220	Quinoline Complexes with Perchlorates of Bivalent Metals .. .. .	500
Pinjaur Area, Geology of .. .. .	23	RADIATION Induced Congenital Defects in Albino Rats .. .. .	209
Piplartine, A New Alkaloid from <i>Piper longum</i> , Structure of .. .. .	354	Radical Polymerisation (Rev.) .. ..	41
Pituitary Gland of <i>Funambulus pennanti</i> .. ..	317	Radioactive Chlorite in the Bundle-khand Granites .. .. .	360
<i>Plagiostigme deodikarii</i> from India .. ..	561	— Upper Vindhyan Pelitic Sandstone Radioactivity of the Silaceous Black Shales at Nagarjunasagar Dam Site .. ..	120
Plant Fossils in the Nimar Sandstone .. ..	21	Radio Spectrum of SH-Radical .. ..	73
Plasmodial Growth of <i>Physarum uringatense</i> .. .. .	555	Radio Waves from Saturn, Linear Polarization of .. .. .	340
Plasticizers Based on Epoxidised Cashewnut-Shell Liquid .. .. .	237	Radio Waves from Saturn, Linear Polarization of .. .. .	157
Plastic Lasers .. .. .	72	<i>Radipholus similis</i> , Occurrence of, in Abbottabad .. .. .	462
Polarised Light (Rev.) .. .. .	399	Raman-Type of Modified Scattering in X-Rays .. .. .	240
Pollen Morphology of Two Indian Species of <i>Balanophora</i> .. .. .	501	Random Variables and Probability Distributions (Rev.) .. .. .	187
— — — Species of Orobanchaceae .. ..	373	Raptakos Medical Research Board Fellowships .. .. .	45, 289
— Production in Allergenic Plants .. ..	557	Rats, Studies on, Bombay .. .. .	457
Poly- $\beta$ -Hydroxy Butyric Acid, Accumulation of, by Activated Sludge Bacteria .. ..	566	<i>Rauwolfia serpentina</i> , A Giant Variety, Reactor Safeguards (Rev.) .. ..	482
Polyphenols of <i>Psidium guarjava</i> Plant .. ..	171	<i>Reboulia hemisphaerica</i> , Occurrence of Compound Female Receptacles in .. ..	285
Postembryonic Development of Pterothoracic Sclerites in <i>Dysdercus kaenigii</i> .. ..	15	Recent Progress in the Chemistry of Natural and Synthetic Colouring Matters (Rev.) .. .. .	372
Potassium Nitrate and Carbohydrate Contents of <i>Argemone mexicana</i> .. ..	139	Red Rot Disease of Sugarcane, Role of Enzymes in .. .. .	332
Potentiometric Studies of Cadmium-3-Aminopyridine Complexes .. .. .	87	Reports on Progress in Physics (Rev.) .. ..	81
Practical Chemistry (Rev.) .. .. .	410	Resolution of ( $\pm$ ) Butane-2-ol .. ..	137
— Physical Chemistry (Rev.) .. .. .	130	— — — Mandelic Acid .. .. .	111
Prehnite from Pinnapuram (Andhra Pradesh) .. .. .	45	Rhenium, Occurrence of, in an Indian Copper Ore .. .. .	260
Primary Production in Upland Lakes of Madras .. .. .	53	Rhizocephala (Rev.) .. .. .	74
Prizes for Scientific Articles .. .. .	525	<i>Rhizopus sexualis</i> from Indian Soil .. ..	478
Problems of Operating Research Ships .. ..	572	<i>Rhizopus communis</i> , Cell Divisions in the Endosperm of .. .. .	186
Proceedings of IGY Symposium (Rev.) .. ..	510	Role of Atomic Electrons in Nuclear Transformations .. .. .	28
— — the Eastern Theoretical Conference (Rev.) .. .. .	19	— — Blue-Green Algæ in Nitrogen Economy of Indian Agriculture (Rev.) .. ..	440
<i>Proceras polycharysa</i> , Occurrence of, in Rice Stubble .. .. .	551		
Production of an Antibacterial Substance by <i>Hydrodictyon reticulatum</i> .. ..	261		
<i>Proleptonchus cestivus</i> (Nematoda: Dorylaimoidea) .. .. .			
Protease and Diastase Activity in the Roots of <i>Plumbago zeylanica</i> .. ..			

	PAGE		PAGE
Role of Blue-Green Algæ on Paddy Yield	441	Site of Synthesis of Alkaloids in Some Plants	355
— — Enzymes in Red Rot Disease of Sugarcane	81	S-Methyl Cysteine Sulphoxide, Identification of, by Paper Chromatography	353
Russian Twin Cosmonauts in Space	292	Snow Crystals Formed in Cirrus Clouds	160
SALT-PSEUDOMORPHS in the Vindhya's, Occurrence of	574	Soil and Freshwater Nematodes (Rev.)	479
Satellite Designation, New System for	386	Solid State Physics (Rev.)	572
— Gyroscope Experiment to Test Relativity Theory	388	Space Activities will Reduce Van Allen Belt	575
<i>Santalum album</i> as Host to <i>Cuscuta reflexa</i>	32	Specific Phenolic Body, Occurrence of, in <i>Santalum album</i> Leaves	11
— — Hosted with <i>Lantana camara</i> , Occurrence of a Phenolic Body in	11	Spectrophotometric Detectoin of Tricresyl Phosphate (TCP) in Food-stuffs	297
<i>Saraca indica</i> , Chemical Study of the Plant	502	Sporadic E-Relationship with Thunderstorms and Magnetic Disturbances	206
Schlieren Methods (Rev.)	573	Sporæ Dispersæ of the Rust Fungi	271
Science of Flames and Furnaces (Rev.)	89	Squalls in India	534
— Progress	142	Spot Test Method of Detection of Bismuth in Presence of Copper	13
Sclerotoids in Kargali Coals	263	Statement on Meteorological Rockets	436
<i>Scolytplotypus raja</i> , A New Record, of Apple Trees	86	Sterility in Pearl Millet	38
Scutellar Bristles in <i>Culicoides</i>	123	Stimulated Raman Scattering from Lattice Vibrations	529
Search for Submuons	489	— — — in Organic Liquids	93
Seasonal and Diurnal Changes of Circulation over India	100	Strange Particles and Strong Interaction (Rev.)	380
Section Cutting in Microscopy (Rev.)	288	Stratigraphic Position of Sedimentary Rocks in Singhbhum (Bihar)	121
Sedimentation in Rajahmundry Area, Economic Significance of	119	Stratigraphy of Pachmarhi Formation	22
Semiconducting Polymers	575	Strontium in Indian Vegetables	418
Sensory Canals of the Head of Cypri-nids	126, 266	Strontium-90 in Soils	339
<i>Septoria</i> , A New Species of, on an Economic Host	367	Structural Features and Neurotoxic Action of a Compound from <i>Lathyrus sativus</i> Seeds	153
Serum Inorganic Phosphate, Changes in, Following Ingestion of Protein	21	Structure of Cyanomaclurin	251
Sheath Blight of Rice Caused by <i>Rhizoctonia solani</i>	328	— Reports for 1953 (Rev.)	381
Shipworms from the Pulicat Lake	215	Submuons, Search for	489
Shoot Apex in <i>Dorotheanthus bellidifomis</i>	377	Substituted Oxadiazole-2-Thiomes	257
<i>Shorea robusta</i> , Chemical Extractives of Heartwood of	544	Sulphomethylation of Acetoacetyl-amides	17
Seasonal Variations in the Cuticle of Myriapoda	412	Summer School	576
Selective Digestion in the Major Carps of India	79	Sunnhemp Mosaic Virus, Effect of Copper Nutrition on Multiplication of	519
— Reduction of Carboxy and Cyano Groups in the Presence of Carbonyl Groups	404	Supersupernovæ Explosion, Evidence for	528
Simultaneous Occurrence of <i>Corynebacterium tritici</i> and <i>Ustilago tritici</i> in Wheat	290	Surface Phenomena in Metals and Alloys (Rev.)	41
<i>Singhiatrema longifurca</i> , Study of the Miracidium of	551	Suspensor Polyembryony in <i>Garrya veatchii</i>	468
Single Crystal Growth from Aqueous Solution	292	Symposium on Elastic-Plastic Deformation	434
		— — Glycosides and Saponins	574
		— — Nucleic Acids	482
		— — Selection of Sites for Reactors	205
		— — Utilization of Metallurgical Wastes	434

	PAGE		PAGE
Synthesis of ACTH .. ..	576	Ultrasonic Waves Rotated by Magnetic Field .. ..	291
— — Adenine .. ..	483	Uptake and Binding of Cobalt-60 and Its EDTA Chelate by Rat Skin ..	8
— — Feedback Systems (Rev.) ..	382	Uranium, New Use for Depleted ..	388
— — ( $\pm$ ) Fustin and Its Derivatives ..	112	U.S. Astronaut Gordon Cooper ..	292
— — 1,1-Diphenyl 4-Substituted Thiosemicarbazides .. ..	159	Use of the Chemical Literature (Rev.) ..	334
— — 3,4-Coumarin-Pyrones .. ..	406		
TABLE of Sines and Cosines (Rev.) ..	40	VANADYL Sulphate, Photolytic Preparation of .. ..	305
Taste Deficiency in a Student Population ..	225	Vanda Seeds, Effect of Chlorox on the Germination of .. ..	467
Taxonomic Status of <i>Jussiaena suffruticosa</i> Linn. .. ..	443	Vascular Anatomy of <i>Limeum indicum</i> Flower .. ..	227
Tectonic Features of Pinjaur Area .. ..	77	Vaucheriaceæ (Rev.) .. ..	190
Telstar, Brain Signals Transmitted via .. ..	243	Vavilovoid Mutant in <i>Triticum aestivum</i> ..	132
Tephrosia Pers., Cytology in the Genus ..	345	Velifer africanus, A Rare Fish From the Bay of Bengal .. ..	80
Terpenes, Studies in .. ..	259	Velocity of Light in Terms of Primary Atomic Constants .. ..	340
Tetramery in <i>Tulipa stellata</i> .. ..	419	Venus's Magnetic Field .. ..	48
Textural Peculiarity in a Dolerite Dyke in Mysore .. ..	505	Vertical Zonation and Seasonal Variation in the Growth of <i>Porphyra</i> ..	173
Therapon jarbua, Changes in the Gills of, with Varying Salinities ..	214	Vibrational Raman Intensities in Gases ..	435
Thermal Analysis of Altered Rocks from Vempalle Limestone Belt ..	358	Vinyl Polymerisation Initiated by Cobaltic Ions .. ..	303
Thermoelectricity in Irradiated Glass ..	46	Visual Acuity and Its Variations ..	531
Thin Film Chromatography (Rev.) ..	523	— Pigments and Their Location in the Retina .. ..	389
Thyriothea of Asterineæ from Lignite ..	327	Volatilization of Boron in the D.C. Arc ..	158
Tick Paralysis in Rabbits .. ..	116	Volcanic Features of the Dalma Lavas ..	314
Tin-Silver Alloys, Properties of Silver-Rich .. ..	143	Volcanicity and Gravity Anomaly ..	193
Toxicity of Zinc to Fish .. ..	363		
Trace Elements in Human and Animal Nutrition (Rev.) .. ..	140	WATER-SOLUBLE Alkaloids of the Root Bark of <i>Cissampelos pareira</i> ..	114
Trade Directory (IMDA) (Rev.) .. ..	525	Watumull Memorial Awards .. ..	337
Training Programme in Physiology of Reproduction .. ..	155	Wealth of India (Raw Materials) (Vol. VI) (Rev.) .. ..	43
Trematoda and Trematode Diseases ..	575	WHO Publication .. ..	46
Trichomes of Compositæ, Mode of Development in .. ..	27	Wood-Boring Crustacean <i>Sphæroma triste</i> , Occurrence of, on the Indian Coast .. ..	168
Trichromatic Hypothesis .. ..	245		
<i>Trichuris discolor</i> from Goat .. ..	435	<i>Xiphinema brevicolle</i> (Nematoda : Dorylaimoidea) from Dalhousie ..	508
Tricrezyl Phosphate (TCP), Spectrophotometric Detection of .. ..	297	X-Ray Induced Tall Mutant of Black Gram .. ..	469
<i>Triticum aestivum</i> , Induced Sphaerococcoid Mutations in .. ..	539	X-Rays from Sources Outside the Solar System .. ..	93
Type-N Gravitational Waves in Non-Empty Space Time .. ..	350		
Tyrosinase Inhibitor, Occurrence of, in the Hæmolymph of <i>Galleria mellonella</i> .. ..	516	ZOOLOGICAL Society .. ..	192
ULTRASONIC Internal Conical Refraction ..	529	<i>Zygnemaceæ</i> , Some New Records of ..	567
— Thermometers for Low Temperatures ..	338		



# THE INFRA-RED BEHAVIOUR OF THE ALKALI HALIDES

SIR C. V. RAMAN

## 1. INTRODUCTION

**X**-RAY diffraction techniques enable us to ascertain the distribution within the volume of a crystal of the atoms composing it. But the geometry of the structure cannot by itself form the basis for any valid deductions regarding the physical properties of the crystal. To enable any such deductions to be made, a knowledge of the spectroscopic behaviour of the crystal is essential. By a careful investigation of a few particularly simple cases, the basic principles connecting structure and spectroscopic behaviour may be elucidated and established. Such an investigation has been carried out in the case of diamond which is accessible to spectroscopic study by a variety of methods. It will suffice here to refer to a recent memoir\* by the author in which the infra-red absorption spectra of diamond have been described and explained in terms of its crystal structure. In an article which appeared in *Current Science* for October 1962, this work has been briefly summarised.

## 2. THE ALKALI HALIDES

Whereas diamond stands apart by itself as a crystal composed of atoms all of one kind which is favourable for spectroscopic investigation, we have in the alkali halides a whole family of crystalline solids which are accessible to study by well-known spectroscopic methods. The fluorides, chlorides, bromides and iodides of the alkali metals lithium, sodium, potassium and rubidium (sixteen in all) have a similar structure. They exhibit a wide range of variation in their physical behaviour and for that very reason, are highly important as materials for study. In a recent memoir by the author,\*\* an attempt has been made to deal with all these sixteen crystals from a unified standpoint and to establish connections between their spectroscopic behaviour and their physical properties. We may here briefly indicate the contents of that memoir.

\* The Infra-Red Absorption by Diamond and Its Significance. Memoir No. 129 of the Raman Research Institute; also *Proc. Ind. Acad. Sci.*, Sec. A, Vol. LV, pages 1-61, 1962.

\*\* The Specific Heats of the Alkali Halides and Their Spectroscopic Behaviour. Memoir No. 131 of the Raman Research Institute; also *Proc. Ind. Acad. Sci.*, Sec. A, Vol. LVI, pages 1-69, 1962.

Part I is a general introduction in which the physical constants of the sixteen halides and especially their elastic moduli are tabulated. In Part II, the nine modes of free vibration of the atoms in a crystal having the rock-salt structure are deduced and described. Parts III and IV contain further developments of the dynamical theory and contain expressions for the frequencies of the nine normal modes in terms of the interatomic force-constants. In Part V it is shown how these frequencies may be numerically evaluated, if only as a first approximation. The results of the evaluation are tabulated in Part VI. Parts VII, VIII and IX deal respectively with the specific heat problem, the infra-red behaviour of the crystal and the spectral shifts observed in light-scattering from first principles. Parts X, XI and XII give the results of the specific heat computations for all the sixteen halides and compare them with the experimental data in the cases for which they are available.

## 3. THE SPECTRUM OF FREE VIBRATIONS

The dispersion, absorption, and reflection of infra-red radiation by a crystal are effects arising from the interaction of the electromagnetic field in the radiation with the structural units composing the crystal. As a first step toward an understanding of these effects, it is necessary to consider the nature of the spectrum of the free or spontaneous vibrations of these structural units. We may deduce their modes and frequencies by the methods of classical mechanics. For this purpose, the atomic nuclei may be regarded as simple mass particles and the electronic clouds surrounding them as massless springs which hold the structure together. The relevant theory is fully set out in the memoir cited above and it is sufficient here to state the results to which it leads. It emerges that the vibrational mode of highest frequency of the structure is one in which the metal and halogen atoms oscillate against each other in opposite phases. Eight other modes of free vibration are also possible. They may be described simply in terms of the crystal structure: four of the modes are oscillations of the cubic layers, while the other four modes are oscillations of the octahedral layers, the movement alternating in phase from layer to layer, and being either normal or

tangential to those layers. Since the oscillations of the metal and halogen atoms may be either in the same phase or in opposite phases, we have four modes for the cubic layers and four modes for the octahedral layers, and hence eight in all. The oscillations of the metal and halogen atoms located in the same cubic layers would be coupled with each other. But the oscillations of the metal and halogen atoms appearing as distinct layers in the octahedral planes would be independent.

#### 4. THE MECHANISM OF INFRA-RED ABSORPTION

The absorption of infra-red radiation by a crystal implies the possibility of a transfer of energy from the field to the solid, a quantum of the energy of the incident radiation being taken over and transformed into one, two or more quanta of vibrational energy in the crystal. The possibility of such a transfer arises from the interaction between the electromagnetic field of the radiation and the electric charges present in the structure of the crystal. These charges are of two kinds, *viz.*, the positive charges of the massive atomic nuclei and the negative charges of the mobile electrons. These charges hold each other in place in the crystal structure as an ordered assembly. The roles which the positive and negative charges respectively play in the absorption of infra-red radiation have, therefore, to be discussed.

In all the modes of oscillation with which we are concerned, there are as many atomic nuclei moving in one phase as in the opposite phase, the respective amplitudes of oscillation being such that the centres of inertia of the structural units in the crystal remain at rest. Now, the ratio of the nuclear charges of sodium and chlorine is sensibly the same as the ratio of their atomic weights. As a result of this situation, the movements of the positive charges of the atomic nuclei when multiplied by their displacements and summed up would also cancel out. Hence, the forces exerted by the field on the positive charges in the structure cannot possibly set it in vibration. Thus, we are led to conclude that though the masses of the atomic nuclei appear in the expressions for the frequencies of vibration, the movements of the charges carried by them would not play any role in the infra-red activity of the crystal. Likewise, the movements of the negative charges carried by the electrons would not give rise to infra-red activity if it be assumed that each nucleus has associated with it the quota of electrons needed to neutralise its charge and that these

electrons are carried along with it in its movements.

Thus we arrive at the following two conclusions. Firstly, the infra-red activity of the crystal owes its origin exclusively to the movements of the electrons and of the negative charges carried by them. Secondly, the electrons thus contributing to the activity are not those which are associated with any particular nucleus and participate in its movements, but are those electrons which enter into the structure of the crystal and whose movements are therefore determined jointly by movements of more than one nucleus. Infra-red activity can only arise if the displacements of electric charge thus resulting do not vanish when summed up each element of volume in the crystal. Though these results were derived with reference to the specific case of rock-salt, it could scarcely be doubted that they are of general validity.

#### 5. THE ACTIVITY OF THE NORMAL MODES

Basing ourselves on the foregoing considerations, we can proceed to discuss the possibility of each of the nine normal modes described earlier being excited by incident radiation having the same frequency as the vibration. It is immediately obvious that the mode of highest frequency in which the metal and halogen atoms oscillate against each other in opposite phases could be so excited. For, the movements of the negative charges set up by the movements of the two sets of nuclei, though opposite in phase, would be of unequal magnitude, and hence their resultant would not vanish. The surviving movement of charge could therefore enable the oscillation to be excited by the field. It is also evident that no such excitation would be possible in the case of the eight other normal modes. For, in these modes, the atomic nuclei of either species oscillate in opposite phases in the alternate layers of the structure, and hence the movements of negative electric charge resulting therefrom would cancel out when summed up over any individual volume element in the crystal.

We have next to consider the cases in which the frequency of the incident radiation is a multiple of the frequency of the normal mode under consideration and a quantum of energy of the field if taken up would be transformed to two, three or more quanta of vibrational energy in the crystal. For such excitation to be possible, the movements of electric charge resulting from the vibration should include a periodic component having the frequency of the

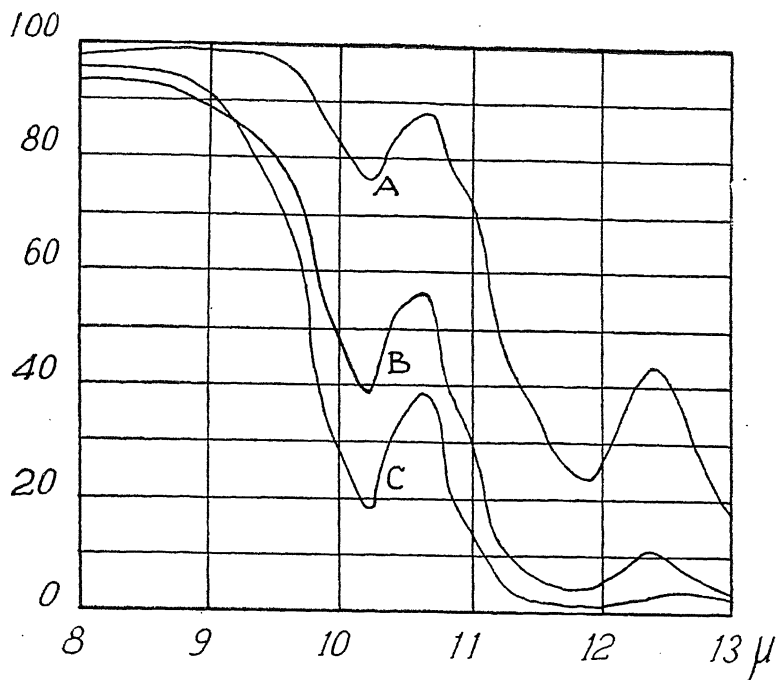


FIG. 1. Magnesium Oxide, Infra-Red Transmission Percentages. Plate thickness : A. 0.06 mm., B. 0.11 mm., C. 0.28 mm.

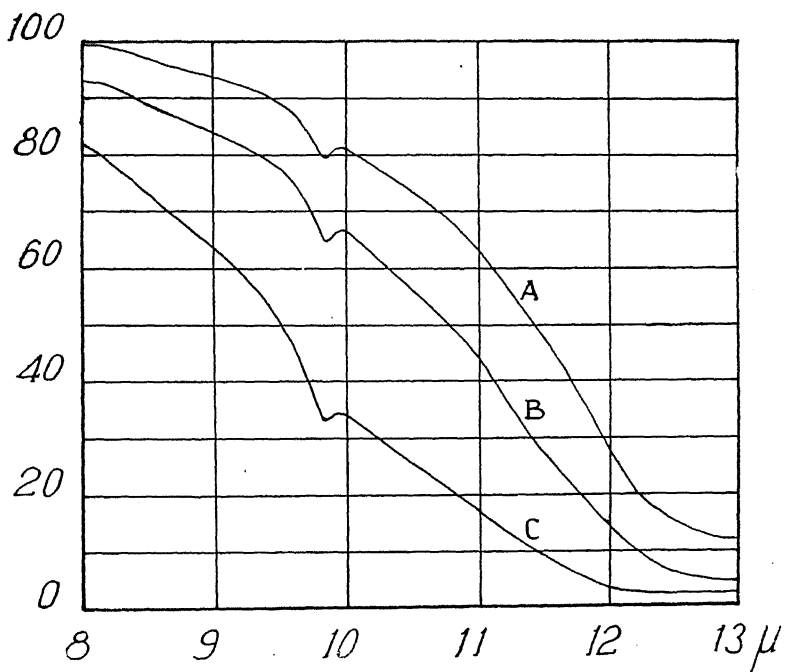


FIG. 2. Lithium Fluoride, Infra-Red Transmission Percentages. Plate thickness : A. 0.10 mm., B. 0.15 mm., C. 0.28 mm.

field which does not vanish when summed up over an individual volume element in the crystal. Electrical anharmonicity associated with a finite amplitude of vibration is requisite for such an effect. It can evidently arise in the case of the vibrational mode which has the highest frequency and the maximum activity of all the modes. It is readily shown also that the coupled modes of vibration of the atomic nuclei in the cubic layers of atoms could be excited by a radiation which has double the frequency of the vibrational mode under consideration. *Per contra*, the symmetry characters of the modes of vibration of the atomic nuclei in the octahedral layers of the structure preclude any such excitation.

#### 6. THE INFRA-RED ABSORPTION SPECTRUM

The considerations set forth enable us in a general way to envisage the behaviour of the alkali halides in respect of the absorption of infra-red radiation. Some supplementary remarks are, however, necessary. By reason of the excitation of the normal modes by radiations having multiple frequencies, the absorption spectrum would extend to much smaller wavelengths than the spectrum of free vibrations of the structure. The strength of the absorptions of higher orders may however be expected to fall off rapidly with the increasing order. Further, the finite amplitudes of vibration excited by the radiation would necessarily involve besides electrical anharmonicity, also a mechanical anharmonicity of the vibrations, and this in its turn involves other consequences. The several normal modes of vibration can no longer be considered as being completely independent of each other or as being strictly monochromatic in their frequencies. Modes which are inactive when considered independently would be rendered active by reason of their contiguity in frequency to other active modes of vibration. In particular, the principal and most strongly active mode having the highest frequency would influence all the other eight modes of lower frequency and render them active to varying extents depending on the differences of their frequencies from that of the mode of highest frequency.

It will be evident from all that has been said above that the characters of the spectrum of free vibrations could by no means be expected to manifest themselves very conspicuously in the spectrum of infra-red absorption. We have indeed to investigate the behaviour in the transmission of infra-red rays pretty thoroughly

using plates of various thicknesses ranging from the largest to the smallest practicable values to enable us to disentangle the various normal modes and their overtones from each other and demonstrate the relationships between the possible free vibrations of the structure and their manifestation in the spectrum of infra-red absorption. Such investigations have been carried out by the author and the results have been presented in a series of memoirs dealing with several individual cases.

A Leitz infra-red recording spectrophotometer was available which was provided with both NaCl and KBr optics, the former covering the wavelength range between  $1\mu$  and  $15\mu$  and the latter the range between  $13\mu$  and  $24\mu$ . The materials investigated can be classed into three groups. The first included the alkali halides NaCl, KCl, KBr and KI commonly used as dispersing prisms for infra-red spectroscopy. Their characteristic wavelengths appear in the remote infra-red. The second group consisted of MgO and LiF whose characteristic wavelengths lay within the range of the KBr optics. Though MgO is not an alkali halide, its structure is similar to that of rock-salt and very significant results were obtained with it. The third group comprised the crystals NaF and  $\text{CaF}_2$ . Their characteristic wavelengths lay beyond the range of the KBr optics, but the records obtained in that range exhibited very significant features. Though the structure of  $\text{CaF}_2$  differs from that of the alkali halides, the results obtained with it present some interesting points of comparison with LiF and NaF.

#### 7. THE SPECTROPHOTOMETRIC RESULTS

The observational data for the cases of MgO, LiF, NaF,  $\text{CaF}_2$  and for NaCl have been set out fully in the individual memoirs dealing with these materials.\* As is naturally to be expected in view of the diversity in the sizes and masses of the combining atoms and of the strength of their binding in these crystals, special features characteristic for each individual material are noticeable in the spectrophotometric records which have been reproduced in the memoirs, and these features are indeed highly significant. Nevertheless, it is possible to trace certain other features common to all the cases studied and which are to be expected in the light of

\* Memoirs of the Raman Research Institute, Nos. 127, 170, 132, 134 and 128—*Proc. Ind. Acad. Sci.*, Section A, Vol. 54, 1961, pages 205-304; Vol. 55, 1962, pages 131-152; Vol. 56, 1962, pages 223-232; Vol. 56, 1962, pages 291-311; and Vol. 54, 1961, pages 253-304.

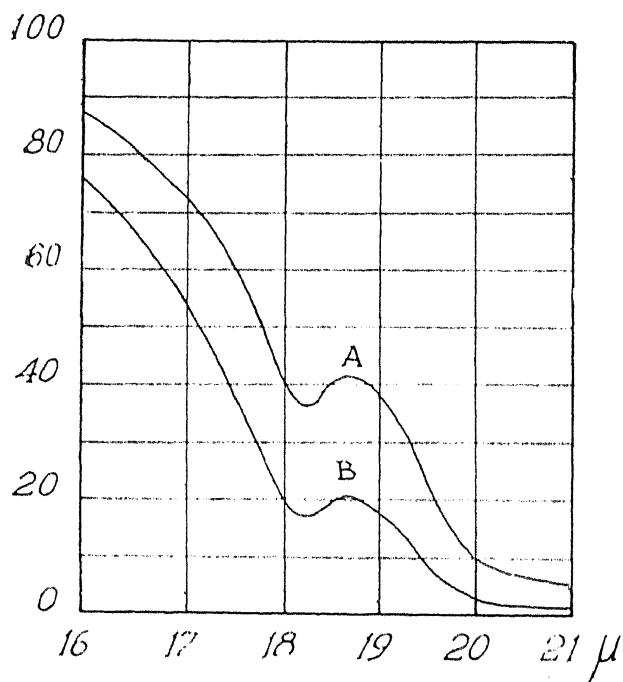


FIG. 3. Sodium Fluoride, Infra-Red Transmission Percentages. Plate thickness : A 0.18 mm., B. 0.36 mm.

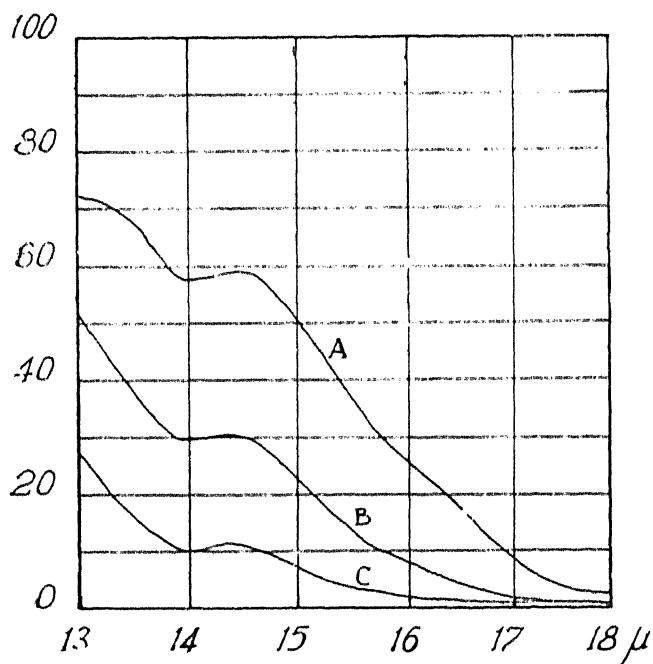


FIG. 4. Calcium Fluoride, Infra-Red Transmission Percentages. Plate thickness : A. 0.11 mm., B. 0.25 mm., C. 0.43 mm.

the theoretical considerations set out above. To illustrate these differences and similarities, some of the records for the different thicknesses of the same materials have been grouped together and are reproduced here as Figs. 1, 2, 3 and 4 in the text. These refer respectively to the cases of MgO, LiF, NaF and  $\text{CaF}_2$ ; and are the records obtained with the thinnest plates made use of in their cases.

Attention may be drawn to the very steep drop in transmission noticed between  $9\mu$  and  $10\mu$  in each of the three curves reproduced in Fig. 1 for MgO. This drop is immediately followed by a sharply defined minimum of transmission at  $10.20\mu$ . A similar but less steep fall between  $8\mu$  and  $9.8\mu$  is noticed in Fig. 2 for the case of LiF and this is followed by a shallow but sharply defined dip at  $9.84\mu$ .

Likewise in Fig. 3, referring to the case of NaF, we notice a steep fall of transmission between  $16\mu$  and  $18\mu$  and this is followed by a well-defined minimum at  $18.2\mu$ . In all the three cases, the steep drop represents the change in the infra-red absorption due to the mode of highest frequency from the third order to the second order, and the observed minimum of transmission represents the wavelength corresponding to the octave of the fundamental frequency. We are thus enabled to determine the latter accurately from the spectrophotometric records. The dip at  $14\mu$  noticed in all the three curves reproduced in Fig. 4 for  $\text{CaF}_2$  is likewise identifiable as due to the octave of the mode of vibration in which the calcium atoms oscillate in one phase and the fluorines oscillate together in the opposite phase, resulting in a strong infra-red absorption.

#### INDIAN ACADEMY OF SCIENCES: XXVIII ANNUAL MEETING

THE Twenty-Eighth Annual Meeting of the Indian Academy of Sciences was held at Bombay on the 24th, 25th and 26th December 1962 under the auspices of the Bombay University. Dr. V. R. Khanolkar, Vice-Chancellor of Bombay University and a Founder-Fellow of the Academy, inaugurated the session and welcomed the delegates. In his inaugural address he suggested a re-orientation of the educational policy to enable bright students to remain in the academic field.

Sir C. V. Raman, Nobel Prize winner and President of the Academy, delivered the Presidential Address on the "Luminescence of Crystals". Detailing the investigation conducted by him in his laboratory in Bangalore, Dr. Raman said that his researches during the year on the luminescence of fluorite taken together with his earlier researches on diamond pointed the way to fresh avenues of thought and opened up new vistas for experimental study on the fundamental problems of crystal structure and crystal behaviour.

Confining the major portion of his address to an exposition of his entirely new findings on the luminescence of fluorspar, Dr. Raman said that the large collection of fluorspar from all parts of the world available in the museum of the Raman Research Institute in Bangalore, supplemented by fresh specimens from the recently discovered deposit at Amba Dongar in Baroda District, India, and the synthetically prepared

fluorite crystals of high optical quality obtained from U.S.A., Great Britain and Germany, have enabled him to undertake a fact-finding investigation aimed at discovering the nature and origin of the luminescence exhibited by fluorspar, a phenomenon with which he had long been familiar and which had interested him for many years.

Dr. Raman said that the general view on the origin of the luminescence of fluorite was that it arose from the presence in it of chemically undetectable traces of various rare-earth elements. The fact that luminescence of the same characteristic colour was exhibited by specimens from all parts of the world militated against this view. On the other hand, his finding that the luminescence was characteristic of fluorite itself was suggested by the fact that naturally occurring fluorite which was colourless and transparent, and was presumably therefore of the highest purity, as well as synthetically prepared fluorite crystals—prepared from carefully purified calcium fluoride—also exhibited identical luminescence.

Convincing results were obtained, Dr. Raman said, from spectroscopic investigation of the luminescence. The method adopted was to photograph the spectrum of the light emitted by fluorite under ultra-violet irradiation, firstly with the material held at room temperature, and then at the temperature of liquid air. At room temperature the emission appeared as a con-

tinuous band in the spectrum, extending from its violet end right into the blue and green regions. At liquid air temperature the part of the continuous spectrum at the violet end disappeared and was replaced by a sharply defined line emission at 4132 Å. This line emission at identical position was shown by fluorite specimens which differed very much from each other in their colour and intensity of their luminescence.

Further evidence that the line emission at 4132 Å has its origin in the crystal structure of fluor spar is furnished by two other facts. The emission line 4132 Å is accompanied by other well-defined but weaker emission lines on the longer wavelength side, the nearest one being shifted by  $321\text{ cm}^{-1}$ . This shift is identical with the known Raman shift exhibited by fluor spar in the scattering of monochromatic light. Secondly, in the absorption spectrum of white light transmitted through a fluorite crystal, a sharply defined dark absorption line at the exact position 4132 Å is recorded.

On the second day of the session, 25th December, there were two invited addresses. The first was by Professor G. N. Ramachandran of Madras University on "Structure of polypeptides and proteins", and the second by Shri C. Ramaswamy of India Meteorological Department on "Our present knowledge of the interaction between the atmosphere and the ocean".

There was a symposium on "Oceanographic research" in which the following took part: Dr. N. K. Panikkar, Dr. K. R. Ramanathan, Prof. C. S. Ramage, Dr. R. Ananthakrishnan, Dr. P. R. Pisharoty, and Miss Anna Mani.

In the afternoon meeting there was a symposium on "Natural products containing heterocyclic systems with oxygen as a hetero-atom". Dr. K. Venkataraman, Director, National Chemical Laboratory, Poona, led the symposium and the other speakers included Dr. C. R. Narayanan, Dr. P. M. Nair and Dr. A. B. Kulkarni.

Dr. S. Krishnaswamy of Madras University gave a talk on "Marine life in shallow waters".

On the 26th December, the morning session consisted of two invited addresses and the presentation of two papers. The first address was by Dr. E. K. Janaki Ammal on "The changing genetic pattern in the flora of Asia". In the second address Dr. V. R. Khanolkar spoke on

recent trends in cancer research with particular reference to the work in progress at the Indian Cancer Research Centre in Bombay.

Dr. Jacob Chandy presented a paper on "Brain mechanisms of speech and language learning". Dr. M. Wharton Young presented an interesting paper on the "Structure and function of the cochlea".

In the afternoon session Sir C. V. Raman led the symposium on Spectroscopy topics with his presentation on the "Infra-red spectra of crystals". The other speakers in this symposium included Dr. S. S. Dharmatti who spoke on some recent researches on N.M.R. spectroscopy; Dr. R. K. Asundi who spoke on the spectra of rare-earth elements; Dr. B. V. Thosar who spoke on  $\gamma$ -ray spectroscopy with special reference to isotope shifts due to finite volume of the nucleus.

In addition to the symposia and scientific meetings there were two public lectures delivered in the evenings of the second and third days of the session. The first lecture was by Dr. N. K. Panikkar on "The Indian Ocean Expedition" and the second lecture was by Dr. K. R. Ramanathan on "Solar activity and the upper atmosphere".

At the Business Meeting of the Academy held at 3 p.m. on the 24th December, the following were elected Fellows of the Academy: Dr. Hattiangdi, Chief Chemist, Messrs. Hindustan Lever Ltd., Bombay; Dr. L. D. Kapoor, Head of the Division of Botany, Regional Research Laboratory, Jammu-Tawi; Dr. Y. Nayudamma, Director, Central Leather Research Institute, Madras; Dr. T. Radhakrishnan, Head of the Physics Division, ATIRA, Ahmedabad; Dr. M. K. Ramaswamy, Reader in Nuclear Physics, Karnatak University, Dharwar; Dr. E. C. G. Sudarshan, Associate Professor of Physics, University of Rochester, U.S.A.

The following were elected Honorary Fellows of the Academy: Professor Bernardo Alberto Houssay, Nobel-Laureate, Instituto de Biología y Medicina Experimental, Buenos Aires, Argentina; Professor Otto Heindich Warburg, Nobel-Laureate, Germany; Professor Torbjorn Caspersson, Head of the Department of Medical Cell Research and Genetics, Karolinska Institute, Sweden.

THE UPTAKE AND BINDING OF COBALT-60 AND ITS EDTA CHELATE  
BY RAT SKIN

B. NAGARAJAN, V. M. SIVARAMAKRISHNAN\* AND S. BRAHMANANDAM\*\*

Isotope Division, Cancer Institute, Madras-23

UNLIKE the liver which is normally assigned a prominent place, the skin is not usually considered to be very important in intermediary metabolism. But, in the course of our investigations, when we attempted to trace the path of cobalt-60 administered intravenously along with ethylenediaminetetraacetic acid (EDTA) in albino rats, we observed that there is an appreciable accumulation of radioactivity in the skin within a few minutes, the skin being the most preferred tissue in the body and the activity in the liver being negligible. Subsequently, the radioactivity rapidly leaves the skin and is excreted mainly through urine. This rapid passage of the EDTA-cobalt-60 chelate through the skin before being excreted is particularly intriguing, since we have observed earlier that this chelate is rapidly and completely excreted<sup>2</sup> and that in blood it does not combine with any blood protein, but exists as such,<sup>3</sup> which led us to assume that it probably does not react with any body constituent, but is directly excreted as such from the blood stream. With zinc-65 and iron-59 also, we have observed a similar passage of the EDTA chelate through the skin (to be published), and this seems to be common for all EDTA chelates, irrespective of the metal. In view of these observations, we have studied the uptake of cobalt-60 by skin slices *in vitro* and also the nature of the binding of cobalt-60 and its EDTA chelate in the skin. The results are reported here.

Fresh skin from adult albino rats, after removal of hair and washing with saline, is cut into thin slices and used. 300 mg. lots of the slices are incubated for an hour with 0.5 ml. of cobalt-60 tracer (as cobaltous chloride solution, approximately 2000 c.p.s.) and 1 ml. of 0.1 M phosphate buffer of the desired pH the reaction being stopped by the addition of 1 ml. of 30% trichloroacetic acid. The radioactivity in the precipitate is determined after centrifugation, washing and digestion with nitric acid. The optimum pH is found to be 7.8 and the uptake

for one hour at this pH is 17% of the activity in the incubation mixture.

The effect of EDTA on the uptake of cobalt-60 has been studied by the addition of varying amounts (0.1 to 0.5 ml.) of 10 mM EDTA solution to the incubation mixture. The total volume of the incubation mixture is kept constant at 2.0 ml. by the addition of suitable amounts of isotonic saline. At all concentrations tried, EDTA has been found to be strongly inhibitory, the uptake being less than 20% of that of the control. This inhibitory action of EDTA is in sharp contrast to its effect *in vivo*, where a preferential deposition of radioactivity in the skin occurs. EDTA also inhibits completely the uptake of cobalt-60 by liver slices<sup>1</sup> or lung homogenate.

The stability of the binding of cobalt-60 in the skin has been studied through dialysis. Dialysis for 24 hours results, on an average, in the removal of 26.7% of the radioactivity deposited *in vivo* in the skin, of 32% of the activity taken up *in vitro* by normal skin slices or of 27.6% of activity taken up *in vitro* by previously-boiled skin slices. This suggests that cobalt-60 exists in the skin mostly in the bound forms even as in the liver.<sup>4</sup> Also, the amounts removed through dialysis are nearly equal in all the three cases. This implies that the nature of binding is probably identical in all of them.

The binding of cobalt-60 in the skin, ten minutes after intravenous administration as the EDTA chelate, has also been studied. About 50% of the radioactivity in the skin is removed by dialysis for 48 hours, but the amount of activity removed decreases progressively with time so that during the next 48 hours, only about 10% is removed. As such, even at the end of prolonged dialysis for 96 hours, nearly 40% of the original activity still remains in the skin. This strongly suggests that the cobalt-EDTA chelate is at least partly bound to skin proteins. Thus the cobalt-60-EDTA chelate in the skin, with its incomplete dialysability, is in sharp contrast to a mixture of cobalt-60 and EDTA solutions or to the cobalt-60-EDTA chelate in blood, both of which have been observed to be freely dialysable, all the radioactivity being nearly completely removed within

\* Head of the Division, presently a Nuffield Foundation Fellow at the Chester Beatty Research Institute, London, S.W. 3.

\*\* Present address: Chemical Testing and Analytical Laboratory, Guindy, Madras-32.



21 hours.<sup>3</sup> This would imply that, while the EDTA-cobalt chelate does not react with any blood proteins, it undergoes at least partial binding in the skin before it is excreted. Similar evidence for a partial binding of this chelate in the bones and the muscles has also been obtained.

The radioactivity dialysing out from the skin in the above instance can be either cobalt-60 in the ionic form or its EDTA chelate or both. In an attempt to identify the exact forms, the dialysate is concentrated to a very small volume and subjected to electrophoresis on paper strips for 150 minutes in a 'Shandon' vertical-type electrophoresis unit using a current of 25 milliamperes and veronal buffer pH 8.3. Under these conditions, while the ionic form stays very much near the point of application, the chelate moves over  $1\frac{1}{2}$ " towards the anode affording a clean separation. After electrophoresis, the paper strips are dried, the various areas marked, cut into pieces and counted for radioactivity. All the activity dialysed out is

found to be present completely as the EDTA chelate. This supports our view that cobalt-60, administered as certain chelates, moves from one tissue to another in the form in which it is administered—may be in combination with some body constituents, like blood proteins, but never splitting up into the ionic form.

We are grateful to the Director Dr. S. Krishnamurthi, M.S., for his keen interest in this work and to the Department of Atomic Energy, Government of India, for financing this research project.

1. Sivaramakrishnan, V. M., Sekhara Varma, T. N., Brahmanandam, S. and Nagarajan, B., *Proc. Sec. Exptl. Biol. and Med.*, 1962, **110**, 817.
2. —, Sreenivasan, N. G., Sekhara Varma, T. N. and Brahmanandam, S., *Nature*, 1962, **193**, 1195.
3. —, Sekhara Varma, T. N. and Lakshmanan, M. R., *The Proceedings of the Symposium on Proteins*, Aug. 1960, C.F.T.R.I., Mysore, 1961, p. 239.
4. Sekhara Varma, T. N., Nagarajan, B., Brahmanandam, S. and Sivaramakrishnan, V. M., *Ann. Biochem. and Exptl. Med.*, 1962, **22**, 265.

## SOME OBSERVATIONS ON THE CYTOLOGY OF *NICANDRA PHYSALOIDES* GAERTN.

J. VENKATESWARLU AND B. G. S. RAO

*Department of Botany, Andhra University, Waltair*

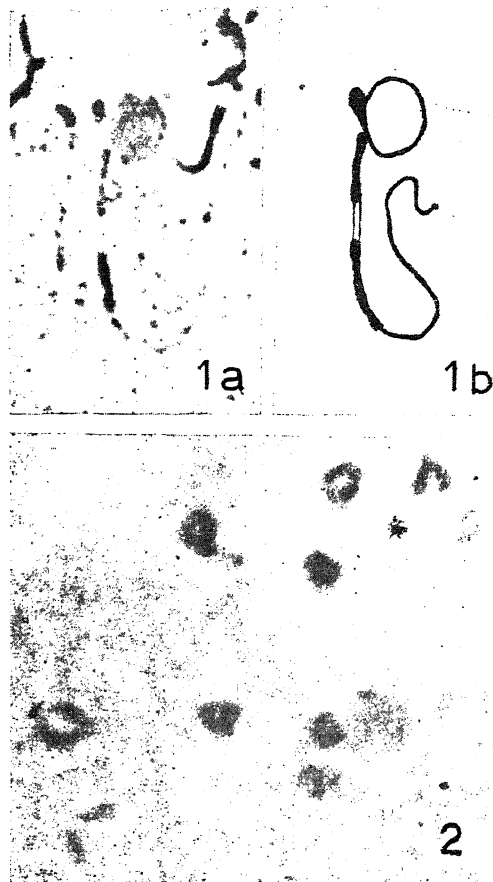
**D**URING the course of a study of the morphology of pachytene chromosomes in some Solanaceae observations were made on the cytology of the monotypic genus *Nicandra physaloides*, var. *immaculata*, raised from seeds obtained from the Royal Botanic Gardens, Kew, and some deviations from those made by Darlington and Janaki Ammal<sup>1</sup> have been met with which are recorded in this note.

Darlington and Janaki Ammal<sup>1</sup> confirmed the previous chromosome counts of  $2n = 20$  made by Vilmorin and Simonet<sup>2</sup> and Janaki Ammal<sup>2</sup> and recorded the occurrence of a pair of isochromosomes with identical satellited arms. These were present in addition to the regular nucleolus organising chromosome pair included in the remaining nine pairs of 'autosomes' such that there were six nucleolus organisers in the complement of the species. The plant investigated by them was therefore interpreted as having "the unique property of being regularly tetrasomic for a part of its chromosomes and

disomic for the rest" at the diploid level. They have also recorded (i) frequent inside pairing of the isochromosomes leading to univalent formation, (ii) irregular distribution of the univalents at anaphase I leading to the formation of microspores and megaspores deficient for the isochromosome and (iii) occurrence of progeny with  $2n = 19$  chromosomes derived from the fertilisation of a deficient egg nucleus ( $n = 9$ ) by a normal sperm ( $n = 10$ ).

In the material studied by us it was found that at pachytene there is a single nucleolus organising bivalent attached to the nucleolus (Fig. 1, *a* and *b*) and this is the only satellited chromosome pair in the complement. There were no isochromosomes in any of the pollen mother cells examined. The chromosome counts, somatic as well as meiotic, however, revealed the presence of  $2n = 20$  and  $n = 10$  chromosomes uniformly. Careful examination of sixty nuclei at diakinesis showed a regular formation of ten bivalents in each of them (Fig. 2) and no

univalents were formed in our material. Disjunction at anaphase I was normal with ten chromosomes regularly passing to either pole and cases of irregular distribution of chromosomes were not met with. Progeny with 19 as



FIGS. 1-2. Fig. 1. Part of a pollen mother cell at pachytene showing the single nucleolus organising bivalent in association with the nucleolus,  $\times 2,000$ . (a, Microphotograph; b, explanatory diagram.) Fig. 2. A pollen mother cell at diakinesis showing ten bivalents one of which is attached to the nucleolus,  $\times 2,000$ . (Microphotograph.)

the diploid chromosome number as would result from the fertilisation of a deficient egg nucleus by a normal sperm has not been encountered. This would be the result when no deficient gametes are formed.

The above findings indicate that apart from races having isochromosomes (satellited) included in their complements, races of *Nicandra physaloides* lacking the isochromosomes totally while at the same time not suffering any numerical deficiency in the chromosome number also would occur in nature and meiosis in them would be regular and normal. The material investigated here obviously comes from such plants.

Since in the materials studied by Darlington and Janaki Ammal<sup>1</sup> the nine 'autosomes' include a nucleolus organising chromosome, the satellited isochromosomes are regarded by them as supernumerary but at the same time of great survival value to the organism as they are considered a necessary requisite for the maintenance of the species in time and space. The present material is not only characterised by the absence of the isochromosomes but also by the presence of a pair of chromosomes not encountered by Darlington and Janaki Ammal such that there are ten 'autosome' pairs in all. More recently Sinha<sup>3</sup> has recorded the occurrence of a supernumerary fragment chromosome ( $2n = 20 + 1$ ) in the somatic complements of two varieties of *Nicandra physaloides*, viz., *violacea* and *arbiflora*. Such fragments, if acentric, would be unstable and are likely to be eliminated from the genome with the consequence that the diploid chromosome number would be 20. A study of various geographical races of the different varieties of the species might throw light on the origin of the satellited isochromosomes and fragment chromosomes in this interesting genus.

The authors are thankful to the Director, Royal Botanic Gardens, Kew, England, for kindly providing the seed material. The junior author is thankful to the Government of India for the award of a Research Training Scholarship during the tenure of which this work was carried out.

1. Darlington, C. D. and Janaki Ammal, E. K., *Ann. Bot. Lond.*, 1945, N.S. 9, 267.
2. Janaki Ammal, E. K., *La Cellulose*, 1932, 41, 89.
3. Sinha, N. P., *J. Indian bot. Soc.*, 1951, 30, 92.
4. \*Vilmorin, R. and Simonet, M., *Verh. V. Int. Kongr. f. Vererb.*, 1927, 2, 1520.

\* Not seen in original.

OCCURRENCE AND SIGNIFICANCE OF A SPECIFIC PHENOLIC BODY  
IN THE LEAVES OF *SANTALUM ALBUM* L. HOSTED WITH *LANTANA CAMARA* L.

Mrs. R. A. SRIMATHI AND M. SREENIVASAYA  
(Forest Research Laboratory, Bangalore)

IN the course of our studies<sup>1</sup> on the influence of host plants on the amino-acid make-up of the leaves of pot-cultured sandal plants grown in association with different species of hosts, it was observed that the paper chromatograms of acetic alcohol extracts of the leaves of a sandal plant grown with *Lantana* as the exclusive host, when left unsprayed in the laboratory for 15-20 days, developed a spot, brownish-grey in colour. This colour gradually deepened into dark grey with time. The period for the development of the colour could be shortened to 2-3 hours, by heating the paper chromatogram in an air-oven running at 100° C. Chromatograms kept in a vacuum desiccator did not show up the colour, suggesting the presence of a spontaneously oxidisable substance in the region. On spraying the chromatogram with a 1% solution of ferric chloride in 96% v/v alcohol, the spot assumes a brownish-grey colour while with diazotised sulphanilic acid, the spot gets a rose red colour. Both these reactions are typically characteristic of phenolic bodies. Earlier work in the laboratory<sup>2</sup> had demonstrated the presence of phenolic bodies in the leaves collected from plantation raised sandal plants whose associated host flora, which is obviously difficult to determine, was not taken into account.

The spot had an  $R_f$  value of 0.34 when butyl acetic water (4 : 1 : 5) was employed as the developing solvent. This value does not correspond to any of the phenolic bodies commonly known to be associated with leaves.

Of the hosts so far examined the phenolic body was found to occur only in the leaves of *Lantana* from which phenol was apparently transferred to the sandal plant through its haustoria without suffering any metabolic change. A study of the distribution of the phenolic body in *Lantana* revealed that the substance is present not only in the leaves but also in the stem and the root.

The finding that sandal plant is capable of absorbing specific constituents like the phenolic

body now under study, from its host plants like *Lantana*, is of considerable practical significance, since it opens up possibilities of influencing the composition of the sap of the sandal plant. The active principles are introduced into the sandal plant through its haustoria, which means that we have now a silviculturally acceptable and practical method of controlling the biochemical make-up of the sap. The degree, the nature and the range of such changes in sap composition which could be brought about depends firstly, upon the variety of host-worthy plants which could be raised in the environment, secondly, the capability of the sandal to establish an effective haustorial connection with each one of them and thirdly, on the transference of the constituents from the host to the parasite either without any change or with an enhanced potency.

By suitable choice of hosts it would thus be possible as indicated earlier<sup>3</sup> to introduce into the sandal active constituents—nutritional factors promoting vigorous growth, antiviral metabolites conferring resistance to spike, insecticidal principles enabling sandal to repel insect vectors and precursors contributing to the formation of the valuable oil-bearing heart wood.

It is thus clear that the study of the influence of hosts individually and in strategic combinations on the biochemical make-up of sandal assumes a new meaning in the light of the present discovery.

One of us, M. S., wishes to tender his grateful thanks to Shri K. P. Sagheiya, President, Forest Research Institute, Dehra Dun, for his kindness in extending to him the hospitality of the Forest Research Laboratory, Bangalore. Our thanks are also due to the Chief Research Officer of the Laboratory for his interest.

1. Srimathi, R. A. and Sreenivasaya, M., *Curr. Sci.*, 1961, 30, 417.
2. Parthasarathi, K. and Ramaswamy, M. N., *J. Sci. and Ind. Res.*, 1961, 20 C, 273.
3. Sreenivasaya, M. and Rangaswamy, S., *Jour. Ind. Inst. Sci.*, 1931, 14 A, 59.

## FLAVONOIDS AND COLD INJURY

S. SANKARA SUBRAMANIAN

Medical College, Pondicherry AND M. K. RAMANATHAN

SINCE the discovery of Szent-Györgyi and co-workers<sup>1,2</sup> that citrin, a mixture of flavonoids including hesperidin under the term of "Permeabilitäts vitamin" or "vitamin P", had the property of reducing capillary fragility and permeability, the biological effects (about 33 kinds of activity) of flavonoids<sup>3</sup> have been studied by various workers<sup>4,5</sup> and their action tried on such clinical conditions as hypertension, diabetes, rheumatic fever, arthritis and pregnancy. In recent years, there has been some claim for the use of flavonoids in the treatment of common cold and citrus flavonoids mainly hesperidin and rutin are included in a number of proprietary remedies in the United States. Dihydroquercetin has also been shown to be effective like rutin, and quercetin has been stated to be superior to rutin in the treatment of initial spontaneous capillary fault associated with hypertension. Although according to Pearson,<sup>6</sup> bio-flavonoids cannot be considered essential as other vitamins in nutrition, the biological activities they possess need not be ignored, and it is worthwhile to re-investigate these properties more systematically in the context of the present emergency and with special reference to our medical needs.

A survey of the literature on the biological effects of flavonoids also reveals that dietary flavonoids have definite influence in frost-bite in rats, and orally administered rutin and related compounds on experimental frost-bite in rabbits. Fuhrman<sup>7</sup> and Crismon<sup>8</sup> of the Stanford University, California, had reported that the extent of tissue loss in rats with frost-bite was less in the group of animals fed with diet containing moderate amounts of flavonoids than in the flavonoid-free group, and particularly the flavonoids were more effective with cases of mild injury. Ambrose, Robbins and De Edds<sup>9</sup> of the U.S. Department of Agriculture, further confirmed this observation and reported that rutin, quercitrin, methyl hesperidin in chalcone and dihydroquercetin all appeared to offer some degree of protection. In the rabbits untreated with flavonoids, most of the frozen foot was involved in the tissue loss, while in the flavonoid-treated ones the loss of tissues was confined chiefly to the toes with partial to complete loss of phalanges.

During the last twenty years, considerable amount of work on the chemistry of flavonoids<sup>5</sup> from Indian plant sources has been reported,

and certain flavonoids have been shown to be potentially useful as anti-oxidants.<sup>5</sup> Special mention may be made of the work of Seshadri and co-workers and the study of gossypetin (8-hydroxy quercetin) for its significant vitamin P activity.<sup>10</sup> This pigment could be isolated in good yields from the flowers of certain Indian Hibiscus species.<sup>10-12</sup>

One of the difficult conditions which our Jawans had to face recently at the Himalayan front has been the bad effects of cold injury, particularly at high altitudes and in view of the limited information available on the different aspects of cold injury, it is suggested that we should undertake a more specific study of the problem of cold injury and the possible use of flavonoids. Here, it is interesting to make special note of the recent report<sup>13</sup> regarding vitamin C in relation to cold temperature tolerance; it has been shown that vitamin C in large doses is beneficial to animals such as rats, guinea pigs and monkeys when they are exposed to a cold environment. Since bio-flavonoids are known<sup>14</sup> to potentiate the effects of ascorbic acid, it would be worthwhile to study the role of bio-flavonoids in conjunction with vitamin C in cold tolerance from the physiological, biochemical and histopathological angles and make use of them. They could also be tried as medicaments in anti-frost ointments.

We thank Dr. S. G. Vengsarkar, Principal, for kind encouragement.

1. Szent-Györgyi *et al.*, *Deut. med. Wochschr.*, 1936, **62**, 1325.
2. Brucker, V. and Szent-Györgyi, A., *Nature*, 1936, **138**, 1057.
3. Willaman, J. J., *J. Amer. Pharm. Assn.*, (Sci. ed.), 1955, **44**, 404.
4. *The Pharmacology of Plant Phenolics*, Fairbairn, J. W. (Editor), Academic Press, New York, 1959.
5. *The Chemistry of Flavonoid Compounds*, Geissman, T. A. (Editor), Pergamon Press, New York, 1962.
6. Pearson, W. N., *J. Amer. Med. Assn.*, 1957, **164**, 1675.
7. Fuhrman, F. A., *Amer. J. Physiol.*, 1955, **181**, 123.
8. — and Crismon, J. M., *J. clin. Invest.*, 1948, **27**, 364.
9. Ambrose, A. M., Robbins, D. J. and De Edds, F., *Federation Proceedings*, 1950, **9**, 254.
10. Seshadri, T. R., *Experientia*, 1955, Suppl. II, 258.
11. Nair, A. G. R., Subramanian, S. S. and Swamy, M. N., *J. Sci. and Ind. Res.*, 1961, **20 B**, 553.
12. —, *Curr. Sci.*, 1962, **31**, 375.
13. Dugal, L. P., *Ann. New York Acad. Sci.*, 1961, **92**, Art. I, 307.
14. Hörhammer, L. and Wagner, H., *Dtsch. Apoth. Ztg.*, 1962, **102** (25), 759.

## LETTERS TO THE EDITOR

SPOT TEST METHOD OF DETECTION  
OF BISMUTH IN PRESENCE OF  
COPPER

Bismuth is a deleterious impurity in several types of alloy compositions.<sup>1</sup> Although some delicate tests are available for the detection of bismuth when present alone, these are subject to interference by other principal constituents. The stannite test<sup>2</sup> or the cinchonine double iodide test<sup>3</sup> for bismuth, for example, needs considerable modification if the test is to be carried out in presence of lead, copper or mercury.

Bismuth, as reported by Girard and Fournau,<sup>4</sup> forms with quarternary ammonium salts particularly tetra-cetyl ammonium hydroxide in presence of alkali iodide and an acidic medium, an insoluble red-coloured compound. Since this compound is very uncommon and not listed in any of the standard catalogues of chemicals, detailed investigations were undertaken to develop the test with tetra-methyl ammonium hydroxide.

Following solutions were prepared :

Bismuth solution : several dilutions were prepared containing from

10  $\gamma$ –120  $\gamma$  of  $\text{Bi}^{3+}$ /ml.

Copper solution—2.5 mg.  $\text{Cu}^{2+}$ /ml.

Tetra-methyl ammonium hydroxide—10% aqueous solution.

Potassium iodide solution—80% aqueous.

Sodium sulphite solution—10% aqueous.

Droppers delivering 20 drops/ml.

One drop of Bi solution and 6 drops of copper solution are mixed together on a spot plate and to the mixture is added potassium iodide solution, and iodine obtained from decomposition of cupric salt removed by the addition of a few drops of sodium sulphite solution. To the solution is now added tetra-methyl ammonium hydroxide, when a white precipitate is obtained. On careful acidification with acetic acid, a coloured precipitate is obtained. In presence of 500  $\gamma$  of copper, 1  $\gamma$  or less of bismuth (ca. 0.2%) gives a yellowish precipitate but with larger quantities of bismuth (5  $\gamma$ ) the colour is distinctly reddish. Unlike the tetra-cetyl

ammonium iodide complex of bismuth, the tetra-methyl ammonium precipitate of bismuth is not extractable with benzene.

National Physical  
Laboratory, Hillside Road,  
New Delhi-12,  
September 26, 1962.

K. C. AGRAWAL.  
J. S. BAHL.

1. *Copper, Its Alloys and Compounds*, Edited by A. Butts, Reinhold Publishing Corporation, New York, 1954, p. 415.
2. Feigl, F., *Spot Tests*, Translated by R. E. Oesper, Elsevier Publishing Co., New York, 1954, 1, 73.
3. *Reagents for Qualitative Inorganic Analysis*, Edited by P. E. Wenger, and R. Duckert, Elsevier Publishing Co., New York.
4. Girard, A. and Fournau, E., *Compt. Rend.*, 1925, 181, 610; Cf. Welcher, F. J., *Organic Analytical Reagents*, D. Van Nostrand Co., New York, 1948, 2, 506.

SEARCH FOR GAMMA-RAYS  
FOLLOWING THE DECAY OF  
3-HOUR  $\text{Ti}^{45}$ 

The decay of 3.1-hour  $\text{Ti}^{45}$  has been studied by several investigators.<sup>1</sup> While the transition directly to the ground state of  $\text{Sc}^{45}$  by electron-capture and positron emission has been well established, the information regarding population of the excited states of  $\text{Sc}^{45}$  has been somewhat contradictory. The measured<sup>2</sup> spin of the ground state of  $\text{Sc}^{45}$  is 7/2, and the parity is presumably odd. From the systematics of levels in the region of f 7/2 ground state orbitals, one may expect that a 5/2 level may exist within a few hundred Kev. of the ground state. From the known positron end-point energy,<sup>3</sup> the Q value for the  $\text{Ti}^{45}\text{Sc}^{45}$  ground state decay is 2.02 Mev., hence there is sufficient energy available for positron decay to an excited state or states, up to an excitation of 1 Mev.

There have been some efforts to observe gamma-rays following the  $\text{Ti}^{45}$  decay.<sup>3-4</sup> The only reported gamma-ray has an energy of 450 Kev.<sup>5</sup> which does not agree with the first excited state energy of 377 Kev. found by Windham *et al.*<sup>6</sup> by inelastic proton scattering experiments. More recently, however, Ishii and Takahashi<sup>7</sup> studied the ( $\gamma, n$ ) reaction on natural Titanium and reported a weak gamma-ray of 377 Kev. They concluded that the intensity of

the branching to that level was about 0.3% of that of the ground state. A study of the gamma-rays in the decay of  $Ti^{45}$  has been undertaken in an effort to resolve the apparent discrepancy.  $Ti^{45}$  was produced by bombarding pure  $Sc^{45}$  with 6-Mev. protons. The single gamma-ray spectrum observed in a  $1'' \times 2''$  NaI (Tl) crystal contained only the annihilation radiation. The gamma-spectrum coincident with positrons was investigated next employing two NaI counters at  $90^\circ$  to each other to minimize annihilation radiation coincidences. The coincidence resolving time was 25 nanoseconds. The coincidence spectrum showed the presence of a gamma-ray of  $270 \pm 10$  Kev. Since a  $90^\circ$  scattering of the annihilation radiation can produce such a gamma-ray, a triple coincidence experiment was performed in which gamma-rays in coincidence with the two annihilation quanta were looked for. In the range up to 600 Kev. no gamma-ray was observed. An upper limit of 0.1% (relative to the ground state decay) could be set on any gamma-ray.

The ground state spin of  $Ti^{45}$  can be either  $3/2$ ,  $5/2$  or  $7/2$  with odd parity. An assignment of  $7/2$  for this and  $3/2$  for the 377 Kev. level seen in inelastic scattering experiments would explain the absence of any gamma-rays following  $Ti^{45}$  decay. The author wishes to thank the hospitality of Prof. P. S. Jastram of Ohio State University where this work was performed.

Dept. of Physics,  
Karnatak University,  
Dharwar,  
November 8, 1962.

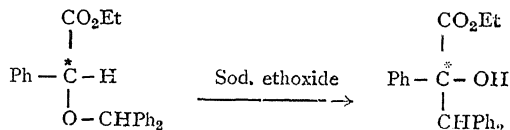
M. K. RAMASWAMY.

1. *Nuclear Level Schemes A=40-92*, Way, King McGinnis and van Lieshout, U.S. Govt. Printing Office, 1955.
2. Kopferman, H. and Rasmussen, E., *Z. Phys.*, 1934, **92**, 82. Schuler, H. and Schidt, T., *Naturwiss.*, 1934, **22**, 758.
3. Kubitschek, H. E., *Phys. Rev.*, 1950, **79**, 23; Ter Pogossian, M., Cook, C.S., Porter, F. T., Morganstern, K. H. and Hudis, J., *Phys. Rev.*, 1950, **80**, 360.
4. Nussbaum, R. H., Lieshout, van R. and Wapstra, A. H., *Phys. Rev.*, 1953, **92**, 207.
5. See Reference (1).
6. Windham, P. M., Gossett, C. R., Phillips, G. C. and Schiffer, J. C., *Phys. Rev.*, 1956, **103**, 221.
7. Ishii, C. and Takahashi, K., *J. Phys. Soc. (Japan)*, 1960, **15**, 736.

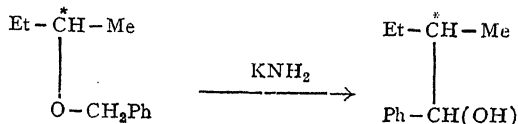
## ISOMERISATION OF OPTICALLY ACTIVE ETHERS

THE nature of the mechanism of rearrangement of benzyl, benzhydryl and related ethers under the influence of Lewis bases, such as  $PhLi$ , has been studied by a number of workers.<sup>1-4</sup> Due to the conflicting results obtained by different workers on various ethers, it was found necessary to trace the steps involved in the process of Wittig rearrangement by stereochemical investigations of the path followed by carbon which undergoes substitution. The following optically active ethers have been prepared and rearranged: (i) ethyl mandelyl benzhydryl ether, m.p.  $48-50^\circ$ ;  $[\alpha]_{D}^{20} - 286^\circ$ ;  $+ 283^\circ$  (1:1); 47%; (ii) benzyl- $\beta$ -butyl ether, b.p.  $94-95^\circ/13$  mm.;  $n_D^{20}$  1.4880;  $\alpha_D^{20} - 21.8^\circ$ ;  $+ 22.0^\circ$ ; 80%; (iii) benzyl-1-phenylethyl ether, b.p.  $97-99^\circ/0.2$  mm.;  $n_D^{20}$  1.5510;  $\alpha_D^{20} - 25.4^\circ$ ;  $+ 23.04$  (1, 1); 85%.

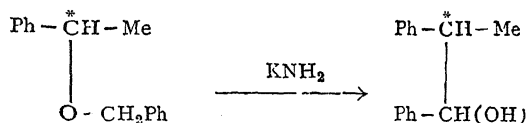
In ethyl mandelyl benzhydryl ether, a symmetrical group has been allowed to migrate from oxygen to carbon ( $C^*$ ) atom which was already dissymmetric and constituted the centre of the molecule which was already optically active, and it resulted in total racemisation of the products formed: ( $\pm$ ) ethyl  $\alpha,\beta,\beta$  triphenyl lactate, m.p.  $118-120^\circ$  (rearranged product); 40%; benzyl ether of ( $\pm$ ) mandelic acid, m.p.  $158-60^\circ$ ; 56%; ( $\pm$ )  $\alpha,\alpha,\beta,\beta$  tetraphenyl ethane, m.p.  $208-210^\circ$ .



Information about the substitution pattern optically active group has been allowed to migrate from oxygen to a symmetric carbon atom and thus a potential centre of optical activity. Optically active benzyl- $\beta$ -butyl ether rearranged to form an optically inactive carbinol: ( $\pm$ ) 1-phenyl-2-methyl-butan-1-ol, b.p.  $120-122^\circ/13$  mm.; 28% unchanged ether, b.p.  $94-95^\circ/13$  mm.,  $[\alpha]_{D}^{20} - 22.0^\circ$ ;  $+ 21.62^\circ$ ; 50%; residue



(+) and (-) benzyl-1-phenyl ethyl ethers formed optically active carbinols on rearrangement: 1, 2-diphenyl propyl alcohols, b.p.  $118-120^\circ/0.2$  mm.;  $n_D^{20}$  1.5689; ( $\alpha$ )  $\alpha_D^{20} - 18.26^\circ$ ;  $+ 17.68^\circ$  (1, 1, alc) 40%



The results support the postulate of earlier workers that the formation of carbinols from ethers were due to the intramolecular rearrangement of the metallated ethers, because non-metallic bases such as dioxan and pyridine failed to bring about any rearrangement. The results further support Hauser's view regarding the formation of benzaldehyde by  $\beta$ -elimination and also that the  $\beta$ -elimination is not followed by rearrangement. The isomerisation of the metallated ethers seems to take place by migration of the organic group and the metal atom *via* intramolecular and intermolecular routes respectively.

It has been observed from the structure of the rearranged product that optical activity contributed to the rearranged carbinol has only been observed in ether containing a phenyl group attached to the potentially active carbon.

(This work has been carried out in the Chemistry Department, Battersea College of Technology, London, S. W. 11.)

Department of Chemistry,  
College of Engineering  
and Technology,  
New Delhi-16,  
November 3, 1962.

J. L. NORULA.  
J. KENYON.

1. Wittig and co-workers, *Ann.* 1942, 550, 260; 1947, 557, 205; 1949, 562, 192; 1954, 558, 145; 1957, 605, 69.
2. Hauser and Kantor, *J.A.C.S.*, 1951 73, 1437.
3. Curtin and co-workers, *Ibid.*, 1951, 73, 2630, 2633; 1954, 76, 494.
4. Stevens and collaborators, *J.C.S.*, 1960, 163, 3521.

### POTENTIOMETRIC STUDIES OF CADMIUM-3-AMINOPYRIDINE COMPLEXES

IN continuation of our previous publication<sup>1</sup> this communication deals with the potentiometric studies of the stepwise stability constants of cadmium 3-aminopyridine, utilizing the method of Leden.<sup>2</sup> 3-Aminopyridine (Fluka), required for this purpose, was purified by recrystallizing from benzene-ligroin. The procedure and the calculations of the stability constants were carried out as described in the earlier publication.<sup>1</sup> The results are recorded in Table I.

A scrutiny of the results shows that 1 : 3 complex formation takes place between  $\text{Cd}^{+2}$  and 3-aminopyridine. The insertion of an

TABLE I  
Cadmium-3-aminopyridine system

Conc. of $\text{Cd}^{+2} = 1.049 \text{ mM}$			Ionic strength = 0.1 M Temperature = $30^\circ \pm 0.1^\circ \text{C}$ .		
[L] (mM)	$\Delta E$ (mv)	$C_M$ [M]	$F_1$ (L)	$F_2$ (L)	$F_3$ (L)
25.05	8.6	1.935	37.32	172.45	736.53
37.91	12.0	2.512	39.88	181.48	724.87
56.96	16.4	3.521	44.24	127.26	759.21
79.04	20.8	4.935	49.78	212.23	737.46
100.03	24.6	6.697	55.05	230.43	764.07
121.77	28.2	8.710	63.32	248.99	780.08
149.06	32.2	11.840	72.72	263.47	754.53
180.09	36.5	16.460	85.56	290.88	757.54
215.45	40.7	22.720	110.86	314.97	747.13
254.62	45.0	31.620	121.26	342.70	747.10
297.42	49.5	44.670	146.83	382.72	769.01
340.84	53.4	60.260	173.86	413.27	760.68
384.42	57.0	79.430	204.02	444.68	756.67
			$\beta_1 = 33 \quad \beta_2 = 154 \quad \beta_3 = 755$		

amino group in 3-position in pyridine increases the basic strength of the molecule ( $\text{pK} = 5.98$ ) due to inductive effect. Hence, cadmium 3-aminopyridine is found to be stronger than cadmium pyridine complex, while  $\log K_1/\text{pK}$  ratio is the same as that of other cadmium complexes (Refer Table II). The value of

TABLE II

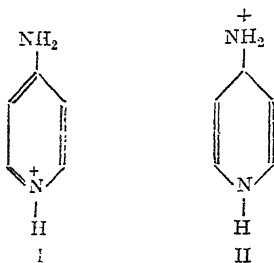
Ligand	$\log K_1$	pK	$R = \log K_1/\text{pK}$
Pyridine*	1.26	5.17	0.244
3-picoline*	1.41	5.68	0.248
4-picoline*	1.50	6.02	0.249
3-Amino pyridine	1.52	5.98	0.254

\* Refer 1.

$\log K_2$  ( $\log K_1 = 1.52$ ,  $\log K_2 = 0.67$ , and  $\log K_3 = 0.69$ ) is much lower than the one required to obey van Pantholeon van Eck<sup>3</sup> relationship. This is attributed to the dipole-dipole interaction between the ligands in the species  $\text{ML}_2$ .

It was, however, impossible to study the complexes of 2- and 4-amino pyridines. When 2- or 4-amino pyridine was added to the cadmium ion solution, a white precipitate was formed. It may safely be concluded that this precipitate was due to hydrolysis of metal ions. The stabilization of metal ion through co-ordination with a complexing agent greatly increases its resistance to hydrolysis and thus makes it possible to keep the metal ion in solution at higher pH than would otherwise be possible. As the pH increases, however, tendency towards hydrolysis of the metal ion increases. 4-amino pyridine ( $\text{pK} = 9.18$ ) is much more basic than

3-aminopyridine due to the resonance effect, caused by structures I and II in its cation.



Hence, the addition 4-amino pyridine increases the pH so much that the hydrolysis of metal ions can no longer be prevented by complex formation. 3-amino pyridine, on the other hand, is relatively a weak base, since, for its cations, no quinonoid structure analogous to II is possible. The addition of 3-aminopyridine to the metal ion, therefore; does not increase the pH beyond limits, and the hydrolysis is effectively superseded by complex formation, whereas in the case of 2-amino pyridine the complex is much more weakened due to the steric hindrance of the amino group. Hence, the resistance to hydrolysis is considerably weakened.

Physical Chemistry Dept.,  
Institute of Science,  
Bombay-1, July 16, 1962.

A. G. DESAI.  
M. B. KABADI.

1. Desai, A. G. and Kabadi, M. B., *J. Ind. Chem. Soc.*, 1961, **38**, 505.
2. Leden, I., *Z. Physikal. Chem.*, 1941, **188** A, 160.
3. van Pantholeon van Eck, *Rec. trav. chim.*, 1953, **72**, 529.

### MYRICONOL FROM THE STEM-BARK OF MYRICA NAGI

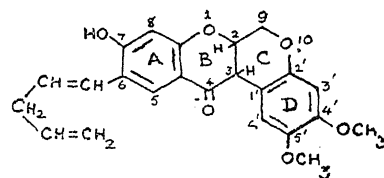
THE stem-bark of *Myrica nagi* has been reported to be a fish poison.<sup>1</sup> It has therefore now been studied in detail and as one of the components a new phenolic rotenoid has been obtained and named Myriconol. It has appreciable fish toxicity though not as high as rotenone.

After initial extraction with light petroleum (60-80°) an ether extract was made and it was fractionated using solubility in bicarbonate, carbonate and 4% aqueous alkali. The last fraction was purified by chromatography on neutral alumina and subsequent crystallisation from benzene light petroleum (40-60°), yielding myriconol, m.p. 114°;  $[\alpha]_D^{25}$  -80.8° (ethanol). It had the molecular formula  $C_{23}H_{22}O_6$  with two methoxyls (micro Ziesel and n.m.r. spectrum) and no C-methyl groups. It contained one

phenolic hydroxyl group (formation of a mono-methyl ether) which however is not chelated (negative ferric reaction).

Its I.R. spectrum supported the presence of a hydroxyl ( $3390\text{ cm}^{-1}$ ) and of a carbonyl group ( $1695\text{ cm}^{-1}$ ). Its U.V. spectrum  $\lambda_{\text{max}}$  260 ( $\log \epsilon$  4.09) and 295 ( $\log \epsilon$  3.92)m $\mu$  and colour reactions (Durham, Roger-Calamari, and Goodhue tests) suggested that it has a rotenoid skeleton. Like other rotenoids myriconol also underwent smooth dehydrogenation to yield the dehydro compound, m.p. 230°, which when degraded gave eventually derric acid. This conclusively established the existence of the chromano-chromanone ring system, the right hand part (Rings BCD see formula I) of which is the same as in rotenone.

Information about the substitution pattern of the left hand benzene ring A (see formula I) was provided by the following considerations. The free phenolic hydroxyl should be present in this ring and since the compound dissolves in sodium carbonate (on maceration) it should be in the 7-position. Catalytic hydrogenation and perbenzoic acid titration indicated the presence of two double bonds. Ozonolysis yielded formaldehyde and another steam volatile compound whose 2, 4 D.N.P. agreed in composition with that of malondialdehyde. It was therefore inferred that myriconol has an unsaturated ( $C_3H_7$ ) side-chain. Since the phenolic hydroxyl was somewhat resistant to methylation it could be concluded that the side-chain was in the 6 or 8-position causing steric hindrance. Choice has been made as 6 by spectroscopic comparison with analogous 3 and 5-C-allyl acetophenones and desoxy benzoin. A tentative structure of the molecule is represented by formula I. This is in accordance with its n.m.r. spectral data: 4 aromatic protons ( $\delta$  6.70, 6.80, 7.15, 7.25); two methoxyls ( $\delta$  3.84, 3.99) and a methine proton adjacent to an oxygen (a signal masked by the methoxyl signals).



The O.R.D. curve of myriconol exhibits negative Cotton effect and the curve is negative throughout the spectral range. Thus its stereochemistry is different from that of other rotenoids so far known, which all exhibit<sup>2</sup>



positive Cotton effect. Since there is no third asymmetric centre it could be concluded that the fusion of the rings B and C is *trans*.

Our thanks are due to Dr. N. S. Bhacca of Varian Associates, California, for n.m.r. data and to Dr. W. D. Ollis, Bristol University, England, for the optical rotatory dispersion.

Chemistry Department, V. KRISHNAMOORTHY.  
Delhi University, N. R. KRISHNASWAMY.  
Delhi-6, T. R. SESHADRI.

December 10, 1962.

1. Chopra, R. N., Nayar, S. L. and Chopra, I. C., *Glossary of Indian Medicinal Plants*, C.S.I.R. Publications, 1956, p. 172.
2. Carl Djerassi, Ollis, W. D. and Russel, R. C., *J. Chem. Soc.*, 1961, pp. 1448.

## NATURE OF COLLOIDS IN CLARIFIED CANE JUICES

THE present communication reports data on the nature of the colloids existing in the clear juice obtained from the sulphitation and carbonation processes, investigated by employing the surface-active agents and electrophoretic technique.

Raw juice was obtained from cane of variety CO 453 from Experimental Sugar Factory, Kanpur. Known volumes of the same were clarified separately following conventional sulphitation and carbonation processes.<sup>1</sup> The clarified juices thus obtained were referred respectively as juices S and C.

Cationic and anionic surface-active agents such as cetylpyridinium bromide (CPB), cetyl trimethyl ammonium bromide (CTAB), sodium lauryl sulphate (SLS) were employed. Limited quantities of surfactants with their large organic ions have the property of coagulating the colloids even at very low concentrations.<sup>2-7</sup> Further, cationic surfactants such as CPB and CTAB were shown to precipitate negatively charged colloids and had no effect on positively charged colloids. Similarly anionic surfactants such as SLS precipitate only the positively charged colloids. It was interesting to note that CPB and CTAB gave appreciable coagulum when added to juice S and had no effect on juice C, indicating thereby that the colloids present in juice S were negatively charged in nature. On the other hand, the anionic surfactants like SLS did not give any coagulum with juice S and showed the indication of positively charged colloids in juice C. Essentially similar result was obtained by electrophoretic studies on the juices S and C. It is of interest to note that while in juice S the colloidal material moved towards anode, the

colloidal material in juice C moved towards cathode. These observations show for the first time that the clarified juices of sulphitation and carbonation processes contained distinct colloids oppositely charged in nature. The colloids in sulphitation juice are negatively charged and the same in carbonation juice possess positive charge while the raw juice contains only negatively charged colloids.<sup>8,9</sup>

Thanks are due to Professor J. P. Shukla and Dr. N. A. Ramaiah of National Sugar Institute for their suggestion and guidance during the work and to Council of Scientific and Industrial Research for grant of Junior Fellowship to one of us (R. D. S.).

National Sugar Institute,  
Kanpur, July 24, 1962.  
R. DAYAL SRIVASTAVA.  
K. A. PRABHU.

1. Honig, *Principles of Sugar Technology*, Elsevier Publishing Company, 1953, pp 585 and 661.
2. Kenjiro Megire and Tamotsu Kondu, *J. Chem. Soc., Japan*, 1955, 76, 642.
3. —, *Ibid.*, 1956 77, 77.
4. Strange and Hazel, *J. Phys. Chem.*, 1957, 61, 1281; *J. Colloid Sci.*, 1957, 12, 529.
5. Bunchi Tamamuchi (Uni-Tokyo), *Kolloid Z.*, 1957, 150, 44.
6. Freundlich and Slottman, *Z. Physik. Chem.*, 1927, 129, 305.
7. — and Birstein, *Kolloid. Chem. Beihefte*, 1923, 22, 95.
8. Ref. 1. p. 528.
9. Ramaiah and Srivastava, Unpublished results.

## SULPHOMETHYLATION OF ACETOACET ARYLAMIDES

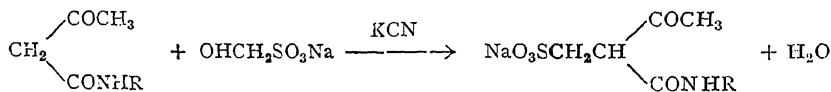
RASCHIG and PRAHL<sup>1</sup> carried out the reaction of acetoacetic ester with potassium hydroxy methane sulphonate and obtained the potassium salt of hydroxymethane sulphonate derivative of acetoacetic ester. Suter, Bair and Bordwell<sup>2</sup> obtained the sulphomethylated product from the compounds containing reactive methylene group and some phenols with an aqueous solution of formaldehyde sodium bisulphite. Sodium 2-hydroxy-1-naphthylmethane sulphonate from 2-naphthol with formaldehyde and sodium sulphite was obtained along with di-2-hydroxy-naphyl-1-methane by Shearing and Smiles.<sup>3</sup> Mehta and Patel<sup>4</sup> carried out the reaction of acetoacet arylamides with sodium hydroxy methane sulphonate<sup>5</sup> and got the methylene bis-(acetoacet arylamides), without any catalyst. Paul Pastour<sup>6</sup> condensed the aliphatic aldehydes with amides and obtained the methylene bis-derivatives.

The sulphomethylation reaction was also carried out by Schwarz *et al.*<sup>7</sup> with some

pyrazolone and N-methyl-p-phenitidine derivatives with formaldehyde and bi-sulphite. Lepetit<sup>8</sup> prepared sodium p-ethoxy phenyl-amino-methane sulphonate ( $\text{EtO C}_6\text{H}_4\text{NHCH}_2\text{SO}_3\text{Na}$ ) from sodium bi-sulphite and formaldehyde with p-phenitidine in water-alcohol medium.

In the present investigation acetoacet arylamides when treated with sodium hydroxy methane sulphonate in the presence of a trace of potassium cyanide gave sulphomethylated product instead of the bis-derivatives.

The structure given below is confirmed from the fact that methylene bis-acetoacet arylamides<sup>1</sup> have been obtained on condensing acetoacet arylamides and their corresponding sulphomethylated products; and also from their melting points, high solubility of crystals in water and from analysis of nitrogen.



where R is phenyl, tolyl, xylyl and naphthyl groups.

#### EXPERIMENTAL

Acetoacet arylamide (1 mole) was dissolved in ethyl alcohol to which an aqueous solution of sodium hydroxy methane sulphonate in presence of a crystal of potassium cyanide as catalyst was added, and the mixture was refluxed on a sand-bath for about half an hour, during which time voluminous precipitate from the reaction mixture was obtained. The product was filtered and crystallised from water in white shining needles.

One of the authors (J. M. T.) thanks the M.S. University of Baroda for giving the facilities to carry out this work.

Chemistry Department,  
Faculty of Science,  
M.S. University of Baroda,  
Baroda, July 10, 1962.

C. M. MEHTA.  
J. M. TRIVEDI.

1. Raschig and Prahl, *Ann.*, 1926, **448**, 265.
2. Suter, C. M., Bair, R. K. and Bordwell, F. G., *J. Org. Chem.*, 1945, **10**, 470.
3. Shearing, E. A. and Smiles, S., *J. Chem. Soc.*, 1937, pp. 1348.
4. Mehta, C. M. and Patel, G. H., *Curr. Sci.*, 1960, **29**, 95.
5. Shriner, R. L. and Land, A. H., *J. Org. Chem.*, 1941, **6**, 888.
6. Paul Pastour, *Compt. rend.*, 1953, **237**, 1094.
7. Farbwerke Vorm Meister, Lucius and Bruning., Beckmuhl, M. and Schwarz, A., *Brit. Pat. No.* 164002, 1925; *Chem. Abst.*, 1927, **21**, 592.
8. Roberto Lepetit, *Atti Acad. Lincei.*, 1917, **26**, 126; *Chem. Abst.*, 1918, **12**, 366.

#### CHARACTERISATION OF INDOLES

DURING the course of synthetic work, it became necessary to characterise some of the indole derivatives. Although some indoles give dark-red or brown crystalline picrates,<sup>1</sup> the latter are sometimes not readily formed and are often difficult to purify. A convenient reagent<sup>2</sup> for the purpose has been found to be sym-trinitrobenzene, which gives well-defined crystalline derivatives. The general method for the preparation of the trinitrobenzene adducts is the addition of hot alcoholic solution of the reagent to the indole dissolved in the same solvent. The crystalline derivatives usually separate out on cooling and can be crystallised from alcohol.

The derivatives listed in Table I have been prepared.

TABLE I

No.	Indoles	m.p. of adducts	Colour	Crystalline form	Molecular formula	% N	
						Found	Required
1	Indole	.. 188-189	Orange	Fine needles	$\text{C}_{14}\text{H}_{10}\text{O}_4\text{N}_4$	17.5	17.37
2	2-Methylindole	.. 183-184	Brick-red	Flakes	$\text{C}_{15}\text{H}_{12}\text{O}_6\text{N}_4$	16.3	17.28
3	2-Phenylindole	.. 145	Red	Fine needles	$\text{C}_{20}\text{H}_{14}\text{O}_6\text{N}_4$	14.0	13.79
4	5, 6-Methylene-dioxyindole	142	Brownish red	"	$\text{C}_{15}\text{H}_{10}\text{O}_8\text{N}_4$	15.0	14.97
5	5, 6-Methylenedioxy-2-methylindole	160	Brown	"	$\text{C}_{16}\text{H}_{12}\text{O}_8\text{N}_4$	15.00	14.77
6	4, 5-Benzindole	.. 205	Brownish red	"	$\text{C}_{18}\text{H}_{12}\text{O}_6\text{N}_4$	14.9	14.73
7	2-(p-Methoxyphenyl)-indole	.. 160	Red	"	$\text{C}_{21}\text{H}_{15}\text{O}_7\text{N}_4$	13.0	12.87

Organic Department,  
Institute of Science,  
Bombay-1, October 19, 1962.

J. R. MERCHANT.  
S. S. SALGAR.

1. Hesse, A., *Ber.*, 1904, **37**, 1457.
2. Redemann, C. T., Wittwer, S. H and Sell, H. M., *J. Amer. Chem. Soc.*, 1961, **73**, 2957; Weller, L. W., Rebstock, T. L. and Sell, H. M., *Ibid.*, 1952, **74**, 2690.

### A SIMPLE DROP RECORDING DEVICE FOR PHARMACOLOGICAL EXPERIMENTS

THE simplest method of perfusion of an organ in Pharmacological investigations, is to connect its artery with a reservoir of suitable physiological saline and to count the drops of perfusate falling down from the organ. The method of visual counting of drops is obviously less convincing to others than a record on a smoked drum and is subject to error especially if the outflow is fast. Other conventional methods of recording the outflow of fluids in such experiments have been described by Bain<sup>1</sup> and Burn.<sup>2</sup> These methods either make use of electromagnetic appliances or employ special types of recording devices. Moreover, except for the method of 'electric drop recorder', these methods are designed to determine the volume changes in the outflowed accumulated fluid.

A simple drop recorder assembled out of readily available apparatus in a pharmacological laboratory is described. It consists of a writing lever, a light pulley and a mayograph lever. A small piece of celluloid film bent at an included obtuse angle, is fixed to the pointer of mayograph. The writing lever is attached by a thread passing over a pulley to the mayograph. The writing lever is adjusted to write on a smoked drum. The outflowing perfusate is allowed to drop on the celluloid film, the lever is pulled down and every falling drop is recorded as a downward stroke of the writing lever on the smoked drum (Figs. 1 and 2).

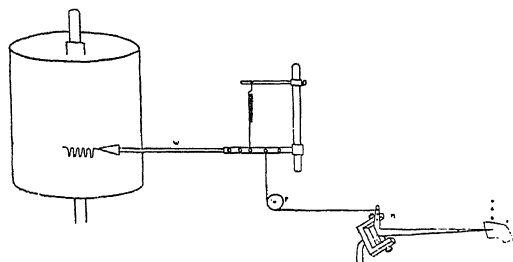


FIG. 1

This method has a fairly large range of registering the rate of outflow and any changes between one drop per minute to about 250 drops per minute are conveniently recorded by suitably adjusting the speed of the drum and time marking. Since working of the device is based on the downward thrust exerted by the drops falling on the piece of celluloid film, both the drop size and the height from which it falls are important factors. It has been observed in control experiments that drops delivered from a height of 10 to 15 cm. by an outflow tube with internal diameter of 4 to 6 mm. are recorded quite satisfactorily. The fluid trickling down from the celluloid film is collected in a receptacle kept underneath it.

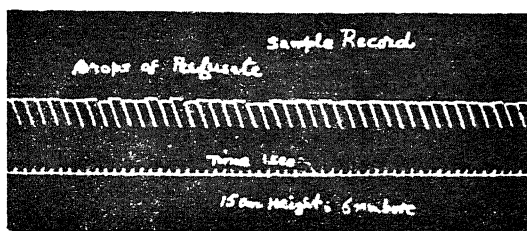


FIG. 2

The assembly also permits sufficient working space between the organ being perfused and the celluloid film. It has been successfully used for recording the outflow rate in 'hind-limb perfusion' and 'isolated heart perfusion' experiments.

Dept. of Pharmaceutics, N. C. NEOGI.  
Banaras Hindu University, R. K. SRIVASTAVA.  
July 18, 1962.

1. Bain, W. A., *Schafer's Experimental Physiology*, Longmans, Green & Co., London, 1938, Ed. VI, p. 123.
2. Burn, J. H., *Practical Pharmacology*, Blackwell Scientific Publications, Oxford, 1952, p. 67.

### PRODUCTION OF AN ANTIBACTERIAL SUBSTANCE BY HYDRODICTYON RETICULAT 'M

INVESTIGATIONS made on a number of planktonic and benthic marine algæ show that they inhibit the growth of several species of Bacteria.<sup>3-7</sup> The production of antibiotics, therefore, appears to be widespread in marine algæ. Very few freshwater forms however have been studied in this respect. Pratt<sup>1</sup> reported the occurrence of a growth-inhibiting substance chlorellin, in cultures of *Chlorella vulgaris* and *C. pyrenoidosa*.

and Marcel and Nisbet<sup>2</sup> observed the presence of extra cellular growth-inhibiting substance in liquid cultures of *Phormidium uncinatum* and *Scenedesmus quadricauda*. Possibilities thus exist of the occurrence of antibiotic activity in the other freshwater Chlorophyceae and Myxophyceae.

Preliminary observations have recently been made on *Hydrodictyon reticulatum* with respect to its antibiotic properties. This alga is common in ponds and pools at Kanpur. It was obtained in culture in 15% soil extract with 1 ml. of 5% KNO<sub>3</sub> and the material from the unialgal culture has been used in the experiments.

To determine the antibiotic activity algal material is thoroughly washed in sterile distilled water and 0.5 ml. by volume of the alga is then crushed in 1 ml. of distilled water. The antibiotic activity of the bright green viscous liquid is then determined by cup assay in the peptone agar plates inoculated with *Bacillus subtilis*. A clear zone of inhibition is observed around the cup while in control no such zone of inhibition is seen. This shows the occurrence of an antibacterial substance in *H. reticulatum*.

Christ Church College, A. B. GUPTA.  
Kanpur, May 29, 1962. G. C. SHRIVASTAVA.

1. Pratt R., *Science*, 1944, **99**, 351.
2. Lereve Marcel and Maud Nisbet, *Compt. Rend. Acad. Sci.*, Paris. 1948 **226**(1), 107; *Biol. Abstr.*, 1950, **24**, 30, 550.
3. Steem n-Nielsen, *Papers Marine Biol.*, Oceanog. De p Sea Research 1955, **3** (Suppl.), 281.
4. Satio and Semeslima, *J. Agr. Chem. Soc.*, Japan, 1955, **29**, 427.
5. Sieburth and Burkholder. *Abstr. of Comm. Intern. Oceanog. Congr.*, 1959, p 933.
6. Allen M. B. and Dawson, E. Y., *J. Bact.*, 1960, **3**, 79, 459.
7. Sieburth, J. M., *Ibid.*, 1961, **1**, 82, 72.

### FREE AMINO ACIDS OF SOME INSECT TISSUE HOMOGENATES

THE high concentration of free amino acids in insect hæmolymph was probably first observed by Nazari.<sup>1</sup> This marked ability of insect tissues to accumulate these has been considered by Florkin<sup>2</sup> as a "systematic biochemical characteristic of insects". The concentration of free amino acids in insect hæmolymph varies from 5 to 20 mg./ml. and comprises 50-80% of the total non-protein nitrogen. Experimental observations suggest that when the "pool" is out of proportion to the actual demand for free amino acids in the hæmolymph, the excess accumulated proves fatal to the insects. This has been demonstrated by Akao<sup>3</sup> in *Bombyx*

*mori* from which the extirpation of silk glands resulted in the twofold increase of free amino acids and subsequently the insects died.

Florkin,<sup>4</sup> Drilhon and Busnel<sup>5</sup> and Harrington<sup>6</sup> have observed marked variations in free amino acid "pool" in insect hæmolymph during such physiological events in their life-cycle as development, moulting, digestion and metamorphosis.

Until the advent of paper chromatography only a few of the amino acids of insect hæmolymph had been identified and even these by very tedious isolation procedures as those employed by Ussing.<sup>7</sup> However, since then, knowledge regarding them has accumulated considerably.

TABLE I

Amino acid	<i>Polytela</i> sp. (larva)	<i>Aulacophora foveicollis</i> (adult)	<i>Epilachna</i> 12-28 <i>punctata</i>	<i>Periplaneta americana</i> (adult)	<i>Dysdercus koenigi</i> (adult)
$\alpha$ -Alanine	+	+	+	+	+
Aspartic acid	+	+	+	+	+
Asparagine	-	-	-	-	+
Arginine	+	+	+	+	+
Cystic acid	-	+	+	+	+
Cystine	-	+	+	-	+
Glutamine	+	-	+	+	+
Glutamic acid	+	+	+	+	+
Glycine	+	+	+	+	+
Histidine	+	+	+	+	+
Iso-leucine	+	+	+	+	+
Leucine	+	+	+	+	+
Lysine	+	+	+	-	+
Methionine	-	+	-	+	+
Proline	+	+	+	+	+
Phenylalanine	+	+	-	-	+
Taurine	-	-	-	-	+
Threonine	+	+	+	+	+
Tyrosine	+	+	+	+	+
Tryptophan	-	+	+	-	-
Valine	+	+	+	+	+

*Note.*—The signs (+) and (-) in the Table signify respectively the presence and absence of the corresponding amino acids in the insects.

The present communication deals with the free amino acid composition of three holometabolous insects, viz., *Aulacophora foveicollis* (adult), *Epilachna 12-28 punctata* (adult) and *Polytela* sp. (larva) and two hemimetabolous insects namely, *Periplaneta americana* (adult) and *Dysdercus koenigi* (adult). Since it was not possible to obtain sufficient quantities of hæmolymph from the insects, tissue homogenates were employed in all cases. These were prepared by homogenizing the decapitated chilled insects with five times their weight of ice-cold water in an all-glass homogenizer. Cuticle

fragments were removed by careful straining. The deproteinised 70% ethanolic extracts were used for chromatography.

The two-dimensional chromatographic technique of Datta, Dent and Harris<sup>8</sup> was followed using 80% phenol-NH<sub>3</sub> and *n*-butanol-acetic acid-water (4:1:5) as irrigating solvents. The uni-dimensional ascending technique also was employed in order to separate and identify the leucines, phenylalanine, tryptophan and valine. Besides 0.1% (w/v) ninhydrin solution in butanol, other specific colour reagents were used to identify proline, arginine alpha-amino butyric acid, histidine and methionine.

Table I represents the results of chromatographic analysis.

Biochemistry Section, RADHA PANT.  
Allahabad University, H. C. AGRAWAL.  
Allahabad, September 19, 1962.

1. Nazari, A., *Reale Acad. Georgofili*, Firenze, 1902, **80**, 356.
2. Florkin, M., *Biochemical Evolution*, Academic Press, Inc., New York.
3. Akao, A., *Bull. Seric. Expt. Sta.*, 1943, **11**, 295.
4. Florkin, M., *Biom. Cont. Acad. roy. Belg. (classe des Sci.)*, 1937, **16**.
5. Drilhon, A. and Busnel, R. G., *C.R. Soc. Biol.*, Paris, 1945, **139**, 926.
6. Harrington, J. S., *Ph.D. Thesis*, University of London, 1955.
7. Ussing, H. H., *Acta Physiol. Scand.*, 1946, **11**, 61.
8. Datta, S. P., Dent, C. E. and Harris, H., *Science*, 1950, **112**, 621.

#### CHANGES IN SERUM INORGANIC PHOSPHATE FOLLOWING INGESTION OF PROTEIN AS SEEN IN A DIABETIC SUBJECT

It was previously reported that when glucose is ingested and simultaneously protein, the peak in blood sugar level of diabetic subjects was lower than when protein was ingested first and 2½ hours later glucose.<sup>1</sup> In seeking an explanation for this difference, the biochemical events in this time interval following ingestion of just protein alone were studied in sequel. We then observed that (a) there was no change in blood sugar; (b) there was a rise in amino N, as was to be expected; but, on the other hand, (c) there was a significant drop in serum inorganic phosphate. The last effect was consistently observed with the three proteins tried (Table I), although in a single diabetic subject. The fall in phosphate level following ingestion of protein does not seem to have been recorded before. Such an observation now made, though preliminary, is,

therefore, noteworthy and hence reported. Experiments with more subjects, both normal and diabetic, are under progress.

TABLE I  
Changes in serum inorganic phosphate following the ingestion of protein

Protein ingested	Serum inorganic (as phosphorus)* mg. %	
	0	2½ hrs. after protein
55 g. protein from blackgram ( <i>Phaseolus m. diatus</i> )	3.48	2.90
55 g. protein from field bean ( <i>Dolichos lablab</i> ), tender	3.20	2.70
55 g. protein from field bean ( <i>D. licho</i> <i>lablab</i> ), mature	3.60	3.10

\* Determined according to the method of Fiske, C. H. and Subbarow, Y., *J. Biol. Chem.*, 1925, **66**, 375.

Recently Danowske *et al.*<sup>2</sup> have reported that hypophosphatemia follows the ingestion of leucine (0.15 g./kg. body weight) in normal subjects. Though the legume proteins used by us have a leucine content of over 8%,<sup>3,4</sup> it is to be verified whether the observed drop in phosphate in 2½ hours following ingestion of protein is all due to leucine and not due at least in part to other amino-acids (or protein fractions) simultaneously released. These aspects as well as the effect of a number of edible proteins on blood phosphate levels in human subjects are being studied.

CFTRI, Mysore, M. SRINIVASAN.  
August 1, 1962. A. NAGABHUSHANAM.  
K. S. SRINIVASAN.

1. Srinivasan, M., *Lancet*, 1957, **1**, 317.
2. Danowski, T. S., Bonessi, J. V., Balash, W. R., and Moses, C., *Metabolism*, 1962, **11**, 556.
3. Ramachandran, M. and Phansalkar, S. V., *Ind. J. Med. Res.*, 1956, **44**, 501.
4. Nagabhushanam, A., Srinivasan, K. S. and Srinivasan, M., *Ibid.*, 1962 (in press).

#### ON THE OCCURRENCE OF PLANT FOSSILS IN THE NIMAR SANDSTONE NEAR UMRALI, DISTRICT JHABUA, MADHYA PRADESH

DURING the course of mapping the 'Bagh beds' in Jhabua District of Madhya Pradesh, a fossil flora, not reported hitherto, was collected in the 'Nimar Sandstone' from a locality 1¼ miles North-East of Umralli (22° 10' 30" N: 74° 19' 10" E). The 'Nimar Sandstone' is considered as of probably Early Cretaceous epoch by Bose,<sup>1</sup>

and regarded as part of Upper Gondwana of Jurassic period by Medlicott.<sup>2</sup>

The sediments of this area are divided into two groups comprising several mappable lithological units, which are given formation status. The stratigraphy near Umralli showing the position of the plant fossils is given in Table I.

done which may yield information in dating the Nimar Sandstone formation precisely.

The authors wish to thank Shri M. C. Poddar, Superintending Geologist, for evincing a keen interest in the work and to Shri L. P. Mathur, Director of Geology, for according permission to publish the note.

TABLE I

Age	Group	Formation	Maximum Thickness	Equivalents in the type area of P. N. Bose
Palæocene?		Deccan Trap -Non conformity-	1000 ft. +	
Danian?		Lameta Limestone -Disconformity-	35 ft.	
Aptian to Senonian	Bagh	Sejagaon Limestone Kanasgoli Grit	49 ft. 6 ft.	Coralline Limestone Deola and Chrakhan Marl Nodular Limestone
Neocomian?		Amlipura Oyster Bed	5 ft.	
Lower Cretaceous?	Nimar	Umralli Flagstone -1 isconformity-	25 ft.	Nimar Sandstone
		Nimar Sandstone (Plant fossils at the basal part) -Unconformity-	210 ft.	
Pre-Cambrian		Granite Gneisses		

The Nimar Sandstone which forms the lower formation of Nimar Group rests unconformably over Granite Gneisses belonging to Champaner Series. The formation consists of two members, a massive conglomeratic sandstone at the base overlain by a sandstone with lenticular light grey carbonaceous clays containing the plant fossils referred to here. The Nimar Group of rocks indicate a fluviatile to lacustrine environment of deposition and is overlain by Bagh Group of rocks which are distinctly marine. The freshwater Lameta Limestone disconformably overlies the Bagh Group while the extensive Deccan Trap lava flows over the above two Groups with a distinct non-conformity.

The plant fossils collected from the basal lutites are identified as: (1) *Ptilophyllum cutchense*, (2) *Ptilophyllum acutifolium*, (3) *Peltate Scale* (Probably Bennettitalean) and (4) *Sphenopteris* sp. This assemblage of fossil flora has clear Upper Gondwana affinity. The upper age limit can, however, be fixed with some certainty at Hauterwian from the absence of angiospermic pollen while the Trilete spore types along with Bennettitalean, Cycadalean and Ginkgo pollen present, give an indication of an Upper Jurassic age to the plant-bearing bed. Further study of the microflora is being

Oil and Natural Gas  
Commission,  
Dehra Dun,  
October 21, 1961.

K. N. MURTY.  
R. P. RAO.  
B. G. DHOKARIKAR.  
C. P. VARMA.

1. *Mem. G.S.I.*, 1884, 21 (1), 20.
2. *Ibid.*, 1884, 10 (1), 133.

#### ON THE STRATIGRAPHY OF THE PACHMARHI FORMATION

THE Pachmarhi sandstones, belonging to the Mahadeva series of the Upper Gondwanas, are exposed in a lensoid outcrop in the northern slopes of the Satpuras. Their present stratigraphic position is below the Denwas in the Mahadeva series (H. B. Medlicott, 1873). The relation of Pachmarhis to Denwas and Bagras is not clear in the field and therefore the basis of this classification is the observed angle of dip in the Pachmarhi rocks. This dip, according to H. Crookshank (1936, p. 232), is such that it brings the Pachmarhis below the Denwas, if extended further north.

The writer has examined the sediments in the Pachmarhi plateau and along the Pipariya-Pachmarhi section to find that the amount of dip is not sufficient to bring them below the

Denwa formation. The sandstones of the Pachmarhi plateau and of the Dhupgarh hill are perfectly horizontal with no tendency to dip towards north. The sandstones show slight amount of dip as one climbs down. The average amount of dip in the whole section from Pachmarhi to Singanama is about 5 to 6 degrees due north. Occasionally it shows higher values up to 10 degrees. At a point on the Pipariya-Pachmarhi road which looks down upon the gorge made by the Denwa river, very beautiful vertical section of the jointed sandstones is exposed. The measurement of dips in this vast section is about 5 degrees only due north. Occasionally it shows horizontal beds also.

From the field data the contact between the Denwas and the Pachmarhis does not appear to be a faulted one. In the absence of a faulted contact the data only suggest that the Pachmarhis may be regarded as younger sediments. There is no other conclusive proof which can make the Pachmarhis older than the Denwas. In the Magaria plain (22° 36'; 78° 6') Crookshank notes the folded Pachmarhis dipping beneath the Denwas, but he himself is in doubt (1936, p. 233) about the identity of the Pachmarhis.

The writer feels that most of the confusion vanishes if the Mahadeva series is not subdivided into the three stages or at least the divisions are not rigidly adhered to. Taking the facies of sedimentation the whole Mahadeva series represents but the same facies. Lithologically the Pachmarhis and the Denwas do not show any distinct difference. The Denwas have more numerous clay beds and the sandstones and conglomerates contain red jasper pebbles. A cursory examination of heavy mineral suite from the two stages has given the same minerals—epidote, magnetite, hematite, blue and brown tourmaline for both.

Sandstones, lithologically very similar to the Pachmarhi sandstones, are exposed in the Tamia scarp (M. S. Krishnan, 1956, p. 271). It is another indication of the younger age of these sediments since the Tamia sandstones overlie the Denwas. Further, Lyddekker's work on the fossil Mastadonsauras (as quoted by Crookshank, p. 240) shows that the Denwas stage is equivalent to the Hawkesbury series of New South Wales. Hawkesbury series unconformably overlies the Newcastle series which is equivalent to Damuda series or the Bijori series in the Satpuras. By comparison the Denwas should unconformably overlie the Bijoris; but here the supposed Pachmarhis are seen to be

overlying the Bijoris. If the Pachmarhis are not separated from the Denwas, the question of their ages does not arise and then Mahadeva series as a whole can be regarded homotaxial to the Hawkesbury series.

In the opinion of the writer, it is desirable to investigate further before accepting the present position of these stages of the Mahadevas and of the boundary in between the so-called Pachmarhi and Denwas formations.

The writer thanks Dr. S. C. Chatterjee for going through the manuscript and for his kind encouragement.

Department of Geology,  
Vikram University,  
Vigyan Bhawan,  
Bhopal, August 23, 1962.

S. K. SAXENA.

1. Crookshank, H., *Mem. Geol. Sur. India*, 1936, **66**, Part 2.
2. Fox, C. S., *Ibid.*, 1931, **58**.
3. Krishnan, M. S., *Geology of India*, 1956.
4. Medlicott, H. B., *Mem. Geol. Sur. India*, 1873, **10**.
5. Medlicott, J. G., *Ibid.*, 1960, **2**.

#### THE GEOLOGY OF THE AREA AROUND PINJOUR

THIS note deals with the stratigraphy, tectonics, palæontology and general distribution of the fossils found in the area around Pinjaur. In fact it summarises the more detailed account of the area which is being published shortly. The resumé also includes a number of new ideas which have emerged from the investigation. Briefly these are as follows:—

(a) If we accept the terrace occurring about 15 ft. above the present river bed as  $T_5$ , the entire terrace sequence  $T_1$ - $T_5$  stands revealed. Though none of the terraces has yielded fossil material, lower Palæolithic stone tools have been found on  $T_1$ .

(b) The Tatrotis have been definitely distinguished (for the first time in this area) as a distinct horizon, equated to the Astian (U. Pliocene).

(c) A distinct fossiliferous horizon (Quranwala zone) has been demarcated within the Tatrotis. It constitutes the uppermost part of the stage and contains a profuse mammalian and reptilian fauna.

(d) The Lower Boulder Conglomerate represents the First, and the Upper the Second Pluvial phase, equated to the Günz and Mindel glaciations, respectively.

(e) Lithological evidence suggests that the beds referred to as Nahans in this area may be equivalents of the upper part of the Chinji, or of the Nurpur series (usually accepted as

transitional between Chinji and Nagri or equivalent of Nagri), not the Nahans, except, very doubtfully, the lowermost sandstone.

(f) *Camelus sivalensis* is now recorded from the Tatrot (U. Pliocene), the known occurrences so far being from the Pinjaura (Pleistocene) only.

(g) *Hipparion* is not found in beds younger than the Tatrots.

(h) The supposed occurrence of *Equus* in the Tatrots as suggested by Lewis is considered doubtful since its *in situ* position has not yet been established.

(i) It may be noted that *Merycopotamus dissimilis* of which the upper limit was previously considered to be Tatrot, is now known to extend slightly higher up into the Pinjaura.

(j) The depositional environment of the Shivaliks is discussed. The entire Shivalik series including the Lower Shivaliks of this area are of freshwater origin. The recent contention by certain authors<sup>1</sup> that the Lower Shivaliks of the area may not be of freshwater origin cannot be accepted in the face of faunal, floral and physical evidence.

(k) There is geological and geomorphological evidence suggesting that the Pinjaur "dun" (between the Upper and Lower Shivaliks) constitutes a rift valley.

(l) A broad study of the Upper Shivalik deposition suggests its cyclical or rhythmic character, besides alternations due to seasonal variation. These and other aspects are being investigated in detail.

Geology Department, M. R. SAHNI,  
Panjab University, EHSANULLAH KHAN,  
Chandigarh,  
December 13, 1962.

1. Sikke, Bhatia *et al.*, *Nature*, October 1961.

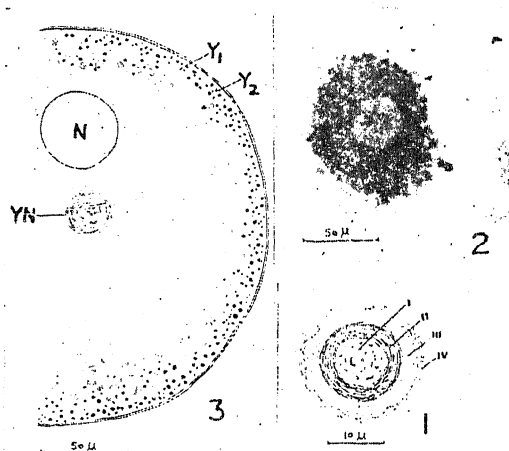
#### HISTOCHEMISTRY AND SIGNIFICANCE OF YOLK NUCLEUS IN OOGENESIS OF THE SPIDER *LYCOSA CHAPERI*

IN the yolk nucleus of spiders lipoprotein<sup>1</sup> and ribonucleic acid<sup>2</sup> have been detected. It has been suggested that this organelle in the spider, *Plexippus paykulli*, is a centre for lipid synthesis.<sup>3</sup> In this communication the histochemistry of the yolk nucleus in the spider, *Lycosa chaperi*, has been studied in detail.

The yolk nucleus in *L. chaperi* originates around the centriole in the immediate vicinity of the nucleus of the newly differentiated oocyte. With the advancement of oogenesis it

develops concentric lamellae and measures up to  $35.5 \mu$  in diameter. Generally it occupies a central position in the cell, while the germinal vesicle is eccentric. The respective diameters of the germinal vesicle and the yolk nucleus are  $4/7$  and  $2/7$  of the oocyte.

Under the phase contrast microscope the yolk nucleus shows concentric lamellae around the central zone; the lamellae close to the central zone are more densely packed than the rest. Cytochemically four zones (Fig. 1) can be made



FIGS. 1-3. Fig. 1. Yolk nucleus (Carnoy/Himes and Moriber's<sup>4</sup> technique) showing four zones. Fig. 2. Lipid bodies synthesized by the yolk nucleus (Ciaccio/<sup>5</sup> ethanolic Sudan black). Fig. 3. Fatty ( $Y_1$ ) and Protein ( $Y_2$ ) yolk arising in the cortical ooplasm (Ciaccio/periodic acid-Schiff). Yolk nucleus (YN) is central and the germinal vesicle (N) eccentric.

out in the yolk nucleus—the innermost zone rich in lipids, the second rich in carbohydrates, the third rich in proteins, and the outermost zone rich in mitochondria and RNA. Morphologically the yolk nucleus in this spider shows a marked resemblance to that of the spiders, *Lycosa pampeana* and *Thomisus* sp., studied under the electron microscope.<sup>2</sup>

The yolk nucleus is colourless in life, osmiophil, argentophil, and contains lipoproteins, some unsaturated lipids, carbohydrates containing acid and neutral mucopolysaccharides and glycogen, proteins containing tyrosine, tryptophan, histidine, arginine, —SH and —SS groups, RNA, and in traces DNA, iron and vitamin C.

In the yolk nucleus are synthesized small lipid bodies (Fig. 2) which, to begin with contain phospholipids but are ultimately transformed into triglyceride bodies. The fatty and the protein yolk globules have no relation with the



yolk nucleus; they seem to arise independently in the well-developed oocyte in the cortical ooplasm (Fig. 3).

The detailed account will be published later.

Sincere thanks are due to Dr. Vishwa Nath, Emeritus Professor of Zoology, for his keen interest and encouragement, and to C.S.I.R. for a scholarship.

Department of Zoology, MADAN LAL SAREEN.  
Panjab University,  
Chandigarh, July 26, 1962.

1. Krishna D., *Sci. and Cult.*, 1958, **23**, 651.
2. Sotelo, J. R. and Irujillo-Cenoz, O., *J. Biophys. Biochem. Cytol.*, 1957, **3**, 301
3. Nath, V., Gupta, B. L. and Manocha, S. L., *Cellule*, 1959, **59**, 387.
4. Himes, M. and Moriber, L., *Stain Techn.*, 1956, **31**, 67.
5. Bradbury, S., *Quart. J. micr. Sci.*, 1956, **88**, 383.

### MARINE CERCARIAE AND THEIR GASTROPOD HOSTS FROM THE PAMBAN MUDFLAT

INDIAN marine cercariae have not received as much attention as the freshwater cercariae have received (Sewell, 1922). A total of 448 specimens belonging to seven genera and eight species of gastropods were collected during May-June 1962 from the Pamban mudflat located in the Rameswaram island (lat.  $9^{\circ} 15'$  to lat.  $9^{\circ} 17'$ ; long.  $79^{\circ} 12'$  to long.  $79^{\circ} 13'$ ). The mudflat surveyed at low tide was nearly a mile long with a maximum width of five to six furlongs. The longer axis of the flat lies in the north-westerly direction and the sea is on the western side. Six different types of cercariae were recorded from four different hosts besides the one described from *Natica marochiensis* by me (Ramalingam, 1960). In Table I, total number of each species examined,

TABLE I

Name of host	Total No. examined	No. infected	%	Type of cercaria
<i>Natica marochiensis</i>	12	1	8.33	Cercaria of <i>Echinochasmus bagulai</i>
<i>Umbonium visitarium</i>	57	5	8.77	<i>Microcerous cercana</i>
<i>Cerithidea fluviatilis</i>	154	20	12.99	<i>Echinostome cercaria</i> Xiphidiocercaria
				" type 1
				" " 2
<i>Cerithium scabridum</i>	21	1	4.76	" " 3
<i>Neritina ovalaniensis</i>	87	8	9.19	" " 4

number infected, percentage of infection and the type of cercariae are presented.

*Pyrene versicolor* (40), *Nassa thersites* (68) and *N. jacksoniana* (9) however showed no infection. A detailed description of the cercariae will be published elsewhere.

In the present study only gastropods were collected and examined as they are known to harbour a majority of cercariae though other animals such as bivalves, annelids are known to harbour cercariae also (Martin, 1944 a, b). Thus while collecting gastropods from the mudflat for an examination of cercariae, some peculiarities in their distribution were observed and are illustrated in Fig. 1.\* It is possible

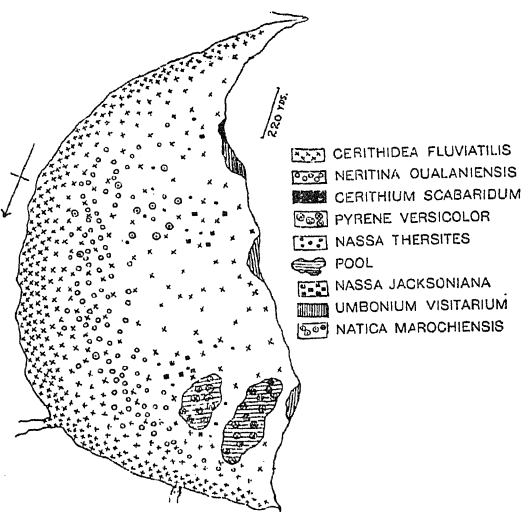


FIG. 1

that other organisms that co-exist with gastropods might show similar peculiarities in their distribution but zonation of gastropods alone is presented as observations were confined to them only.

*Umbonium visitarium* is found at the edge of water at low tide, concentrated in three different regions. *Cerithium scabridum* is highly restricted and occurs in only one region in close proximity to and overlapping to some extent the region predominated by *U. visitarium* at the southern end. *Nassa thersites* and *N. jacksoniana* are found on either side of the middle portion of the mudflat, confined to the region between mid and low tide regions, gradually thinning out as one proceeds towards the northern and southern ends of the mudflat. *Neritina ovalaniensis* is confined to the mid-

tidal region and in this region there is a growth of sea grass *Cymodocea isoctifolia*. A few of these gastropods are scattered on either side of the mid-tidal region. *Natica marochiensis* is more confined to the southern half of the mudflat in the mid-tidal region though stray ones occur at the northern half of the mudflat. *Cerithidea fluvialtilis* is the predominant gastropod on the mudflat and is found scattered all over, but is comparatively more concentrated towards the high tide level. In contrast to this *Pyrene versicolor*, like *Cerithium scabraridum*, is highly restricted and discontinuous in its distribution and is confined to two regions near the northern portion of the mudflat. They are found on the undersurface of the fronds of the sea grass *Enhalus konigii* which grows in pools that retain one to two and a half feet of water at low tide. A similar zonation of animals of the mudflat has been described by Brady (1943) in the Northumberland coast of England.

Observations on the distribution of these gastropods and the examination of these for cercariae at definite intervals over a period might reveal whether the absence of cercaria as observed in some of the above hosts is only seasonal or otherwise, or whether fluctuations in the percentage of infections if any as well as succession of infection by different types of cercariae occur. Besides it will be possible to say how far host-parasite specificity restricts distribution of these parasites in one common ecological zone (the mudflat). Studies on the above aspects are in progress.

I thank the U.G.C. for the grant which enabled me to carry out the work and the Director, C.M.F.R. Institute, Mandapam, for providing me laboratory facilities.

Zoological Res. Laboratory, K. RAMALINGAM.  
University of Madras,  
Chepauk, Madras-5, August 31, 1962.

\* The various signs representing gastropods depict their distribution not quantitatively but spatially.

1. Brady, F., *J. Anim. Ecol.*, 1943, **12**, 27.
2. Martin, W. E., *Jour. Parasitol.*, 1944 a, **30** (3), 191.
3. —, *Trans. Amer. Microsc. Soc.*, 1944 b, **53** (3), 237.
4. Ramalingam, K., *J. Mar. biol. Ass. India*, 1960, **2** (1), 35.
5. Sewell, R. B. S., "*Cercariae indicae*," *Ind. J. Med. Res. Suppl.*, 1922, **10**, 1.

## PHENOMENAL INCREASE IN YIELD OF LEGUMES BY INCORPORATING LIME WITH FERTILISER MIXTURE IN RED LOAM SOILS OF KERALA

HORSEGRAM was grown in randomised plots with the following treatments in red loam soils at the Agricultural College Farm, Vellayani, Kerala. The average yield per acre of treated plots are given in Table I. The growth of the

TABLE I

Yield of legume with different treatments

Treatments	Weight of green pods in kgm. per acre	Weight of green matter with pods in kgm. per acre
Control	176.460	290.400
Superphosphate + Potash	695.760	430.977
Lime + Superphosphate + Potash	2785.333	6023.111

plant is shown in Fig. 1. Experiments were carried out in replicated trials in plots of size of 9' x 9' with 4 replications.

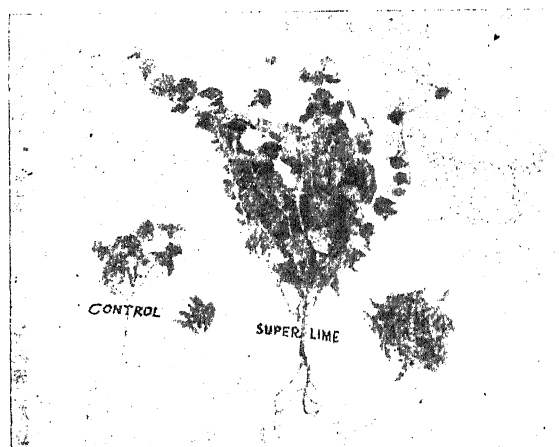


FIG. 1

1. Control: Superphosphate and Potash. 2. Superlime and Potash.

The use of lime is well recognised but the response of a legume has not been studied in Kerala before. Another special feature of the trial is lime and superphosphate are mixed together before application.

The legume yield is likely to get phenomenal increase by lime incorporation. Field trials over

large areas in different soil types of the State are in progress.

Division of Agrl. Chemistry, N. S. MONEY.  
Agricultural College and K. K. C. SENAN.  
Res. Institute, Vellayani,  
Trivandrum, July 31, 1962.

### MODES OF DEVELOPMENT IN THE TRICHOMES OF COMPOSITAE

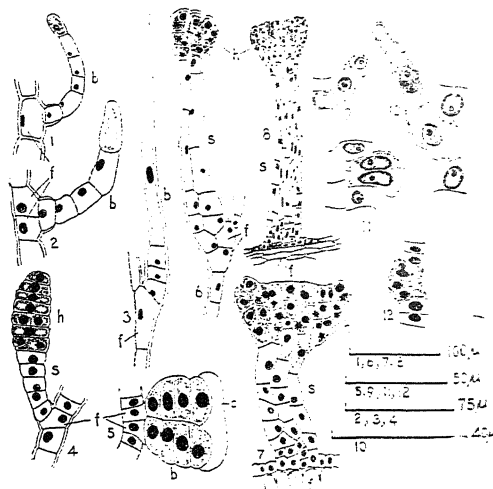
TRICHOMES of vascular plants so far investigated are known to originate from single protoderm initials.<sup>6,7</sup> Among the multicellular trichomes Netolitzky<sup>6</sup> recognises two modes of development depending on the nature of the first division of the initial, viz., where the division is (i) periclinal or oblique and (ii) anticlinal.

Since the last several years the present author is engaged in the study of the trichomes in the Compositae.<sup>8,9</sup> The trichomes have been found to show in all four patterns in their structure,\* viz., (i) filiform, uniseriate (throughout or at least in the body†) e.g., in Figs. 1 and 2, (ii) macroform, uniseriate (throughout or at least in the stalk†) e.g., in Figs. 3 and 4, (iii) biseriate (throughout or at least in the stalk) e.g., in Figs. 5 and 6 and (iv) multiseriate (Figs. 7 and 8). The ontogenetic studies of the trichomes in the family taken up by the author include types from all the above four structural patterns. These reveal that there are three modes of development in trichomes and not merely two as described by Netolitzky (see above). While the details of these studies are being published elsewhere, the modes of development of the trichomes are briefly dealt with in this paper.

As previously described by De Bary<sup>7</sup> and Netolitzky,<sup>6</sup> the trichomes under investigation are found to originate from single initials. Recently, Cowan<sup>5</sup> and Carlquist<sup>2-4</sup> have reported a similar origin for the trichomes of the genus *Rhododendron* and of the subtribe Madiinae (Compositae) respectively. Following are the modes of development:—

I. *The first division of the initial periclinal or oblique* (Figs. 9 and 10).—This is seen among the trichomes belonging to both the patterns I and II type of structure. Further divisions that take place are also periclinal and con-

sequently the uniseriate structure, characteristic of the trichomes of these patterns, is produced (Figs. 1 and 3). The multiseriate condition of the foot (Fig. 2) and the head (Fig. 4) found in these trichomes is due to anticlinal subdivisions in the cells of the respective regions late in the ontogeny.



FIGS. 1-12. Figs. 1-2. Simple Filiform Hairs from the margin of a phyllary in *Adenostemma baccina* (L.) Kuntze and l.s. leaf in *Ageratum conyzoides* L. respectively. Fig. 3. Simple Conical Hair from l.s. disc-corolla in *Blumea amplexans* DC. Fig. 4. Uniseriate Capitulate Glandular Hair from l.s. peduncle in *Placenta australasiae* Hook. Fig. 5. Biseriate Vesicular Glandular Hair from l.s. peduncle in *Eupatorium odoratum* L. Fig. 6. Biseriate Capitulate Glandular Hair from l.s. phyllary in *Blumea bifoliata* DC. Fig. 7. M-Multiseriate Capitulate Glandular Hair from l.s. stem in *Blumea latifolia* DC. Fig. 8. P-Multiseriate Capitulate Glandular Hair from l.s. peduncle in *Sonchus oleraceus* L. Fig. 9. 2-celled stage of Simple Filiform Hair from l.s. leaf in *Glossopetalon bosvallea* (L.f.) D.C. Fig. 10. 2-celled stage of Oblique-aseptate flagellate Hair from l.s. leaf in *Echinops scaberrimus* Roxb. Fig. 11. 2-celled stage of Biseriate Vesicular Glandular Hair from l.s. leaf in *Chrysanthemum indicum* var. *hortorum* Bailey. Fig. 12. An early developmental stage of P-Multiseriate Capitulate Glandular Hair from l.s. peduncle in *Sonchus oleraceus*, consisting of several juxtaposed cells on account of more than one anticlinal division of the initial. (b, body; f, foot; s, stalk; h, head; c, cuticular vesicle. The names of trichomes used above are from Ramayya<sup>8</sup>).

II. *The first division of the initial anticlinal* (Fig. 11).—This is observed among the trichomes of the Pattern III type of structure, and also in some of those of the IV. The juxtaposed dyads resulting from the first anticline afterwards divide by successive periclinal divisions and give rise to the biseriate structure characteristic of the trichomes of the Pattern III (Fig. 5). The multiseriate condition of the foot or the head

\* For detailed description of the patterns see Ramayya.

† A trichome is recognised to consist of a foot (the region lying in the epidermis) and a body (the portion lying above the foot). The body may be entire or differentiated. In the latter case the proximal region is recognised as the stalk and the distal, the head.

(Fig. 6) in these trichomes is again due to anticlinal subdivisions of the cells of those regions in their primordial biseriate stage. In the trichomes with the Pattern IV type of structure, the primordial biseriate stage undergoes the subdivisions throughout its length and hence the wholly multiseriate structure, possessed by these trichomes, is produced (Fig. 7).

III. *The first two or more divisions of the initial anticlinal* (Fig. 12).—This is noticed among the remaining ones of the Pattern IV type of structure. The two or more anticlinal divisions that the initial undergoes results in a group of four or more juxtaposed cells. This establishes the multiseriate structure of the trichomes right at the very outset unlike in the others of this pattern as described above. Further divisions take place in various directions to complete the formation of the trichome (Fig. 8). The Terminal Glands of *Calycadenia* show a similar mode of development as described by Carlquist.<sup>3</sup>

It is obvious that the Pattern IV type of structure has two kinds of origin, one through the II mode of development and the other through the III, so that for the identification of the trichomes belonging to this pattern a knowledge of their mode of development is essential.

In the past several workers<sup>1-6</sup> have taken up the study of the phylogeny of the trichomes. They have traced their relationships according to the concept of the organic evolution 'from simple to complex', but the present studies reveal that more significant evidences in this respect can actually be derived from their structural patterns and modes of development. The author has, therefore, made a detailed study of the relationships of the trichomes in the family by taking into account evidences from the above aspects<sup>9</sup> and will shortly be publishing its conclusions elsewhere.

The author's grateful thanks are due to Prof. M. R. Suxena, Head, Department of Botany, Osmania University, under whose supervision the present work has been carried out.

Department of Botany, N. RAMAYYA.  
College of Science,  
Osmania University,  
Hyderabad-7 (A.P.) (India),  
November 1, 1962.

1. Bower, F. O., *Ann. Bot.*, 1926, **40**, 479.
2. Carlquist, S., *Amer. J. Bot.*, 1958, **45**, 675.
3. —, *Ibid.*, 1959a, p. 70.
4. —, *Ibid.*, 1959, p. 300.

5. Cowan, J. M., *The Rhododendron Leaf. A Study of the Epidermal Appendages*, Oxford & Boyd, London.
6. Netolitzky, F., "Die Pflanzenhaare" in K. Lin-bauer, *Handbuch der Pflanzenanatomie*, 1932, **4** (4), 1.
7. De Bary, A., *Comparative Anatomy of the Vegetative Organs of the Phanerogams and Ferns*, Oxford, 1884.
8. Ramayya, N., "Studies on the trichomes of Some Compositae. I. General structure," *Proc. Summer Sch. in Botany*, Kodaikanal. Govt. of India Publication 1962 (In press).
9. —, "A study of the structure, variations, development and distribution of trichomes in some Compositae," *Thesis*, 1962.

#### INDUCTION OF CELL DIVISIONS IN THE MATURE ENDOSPERM OF *RICINUS COMMUNIS* DURING GERMINATION

ALTHOUGH both the zygote and the primary endosperm nucleus are products of fertilization, the former gives rise to a new plant while the latter produces a nutritive tissue. This contrasting behaviour has been ascribed, with some exceptions, to the usually triploid nature of the endosperm (for details see Maheshwari<sup>1</sup>). *In vitro* culture of the endosperm has been attempted by La Rue,<sup>2</sup> Lampton,<sup>3</sup> Pieczur,<sup>4</sup> Sternheimer,<sup>5</sup> Straus and LaRue,<sup>6</sup> Straus,<sup>7</sup> Norstog,<sup>8</sup> Tamaoki and Ullstrup,<sup>9</sup> and Straus.<sup>10</sup> In all these cases the endosperm was isolated at an early stage of development and it showed potentialities for unlimited growth but without any differentiation.

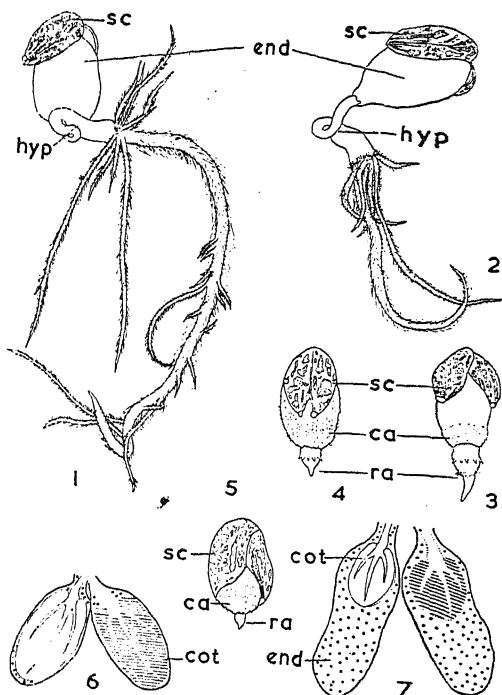
During the germination of an albuminous seed the reserve food materials stored in the endosperm are hydrolysed and made available to the growing embryo. While there is an enormous increase in the size of the endosperm cells due to absorption of water, there is practically no increase in their number.

The following report concerns an interesting observation made while studying the effect of 2,4-D and kinetin on the germination of seeds of castor.

Twenty castor seeds of the variety TMV 1 were soaked in various concentrations of 2, 4-D and kinetin (0; 0.5; 5; 50; and 500 p.p.m. for 8 and 24 hours after pre-soaking in distilled water for 24 hours). After surface drying they were transferred to petri dishes, kept moist by cotton pads soaked in distilled water and stored under the laboratory conditions of light and temperature.

2,4-D treatment resulted in marked inhibition of the growth of the radicle and hypocotyl at 5.0, 50.0 and 500.0 p.p.m. (Figs. 3-5). There was retardation of plumular growth at all con-

centrations of 2,4-D and in the controls (Figs. 1-5). Root growth was normal in the control seeds and those treated with 0.5 ppm. 2,4-D (Figs. 1-2).



FIGS. 1-7. Figs. 1-5. Effect of 24-hours soaking in 0, 0.5, 5.0, 50.0 and 500.0 p.p.m. of 2,4-D respectively on the germination of castor seeds. Note callusing of the endosperm and suppression of radicle in Figs. 3-5. Figs. 6-7. Relative growth of endosperm and the cotyledons in the control (Fig. 6) and kinetin (50 p.p.m.) treated seeds (split length-wise). All Figs.,  $\times 2$  (ca, callus; cot, cotyledon; end, endosperm; hyp, hypocotyl; ra, radicle; sc, seed-coat.)

The endosperm showed callusing at 5.0, 50.0 and 500.0 ppm. (Figs. 3-5). Microscopic examination of the macerated endosperms (in a 1:1 mixture of 10% hydrochloric and 10% chromic acid) showed an increase in cell dimensions at all concentrations as compared with the controls (Table I). Although there was a decrease in cell number at 50.0 ppm. of 2,4-D, the average cell size was greater than at 5.0 p.p.m. At 500.0 p.p.m. both cell number and cell size were greatly increased. The endosperm cells showed a multi-vacuolate condition at higher concentrations of 2,4-D. The oil globules were fewer at 0.5 and 5.0 and they practically disappeared at 50.0 and 500.0 p.p.m.

Kinetin at 50.0 p.p.m. caused a more pronounced growth of the endosperm than 2,4-D. In the control seed the cotyledons (Fig. 6) gradually

enlarged and used up the endosperm while in the kinetin (50.0 p.p.m. treated seeds the growth of the cotyledons was suppressed and that of the endosperm (Fig. 7) enhanced. However, the endosperm did not show callusing.

Cell counts following macerations of endosperm revealed (Table I) that at higher concentrations of kinetin (5.0 and 50.0 p.p.m.) the increase in the number of cells was also accompanied by an increase in cell size.

TABLE I

Effect of 2,4-D and kinetin on size and number of cells of endosperm of *Ricinus communis* (soaking period: 24 hours)  
7 Days' growth

Concentration (p.p.m.)	2,4-D		Kinetin	
	Number of cells per endosperm*	Average diameter of cell in microns*	Number of cells per endosperm*	Average diameter of cell in microns*
0	$8.73 \times 10^9$	72.8	$8.73 \times 10^9$	72.8
0.5	$6.85 \times 10^9$	89.7	$5.48 \times 10^9$	91.0
5.0	$8.91 \times 10^9$	114.1	$9.34 \times 10^9$	164.7
50.0	$6.42 \times 10^9$	194.5	$12.32 \times 10^9$	204.6
500.0	$10.2 \times 10^9$	345.0	..	..

\* Average of 20 counts.

Thus the mature and differentiated cells of the endosperm can be brought to active proliferation by the application of growth-promoting substances. The reason why the capacity for proliferation of the endosperm is inhibited under normal conditions may be due to the action of some substances secreted by the embryo. This inhibition is perhaps overcome by the special growth adjuvants.

The work suggests a technique for raising an actively growing endosperm tissue for morphogenetic and biochemical investigations.

Grateful thanks are extended to Professor P. Maheshwari for his comments.

Department of Botany, H. Y. MOHAN RAM.  
University of Delhi, ASHA SATSANGI.  
Delhi-6, July 5, 1962.

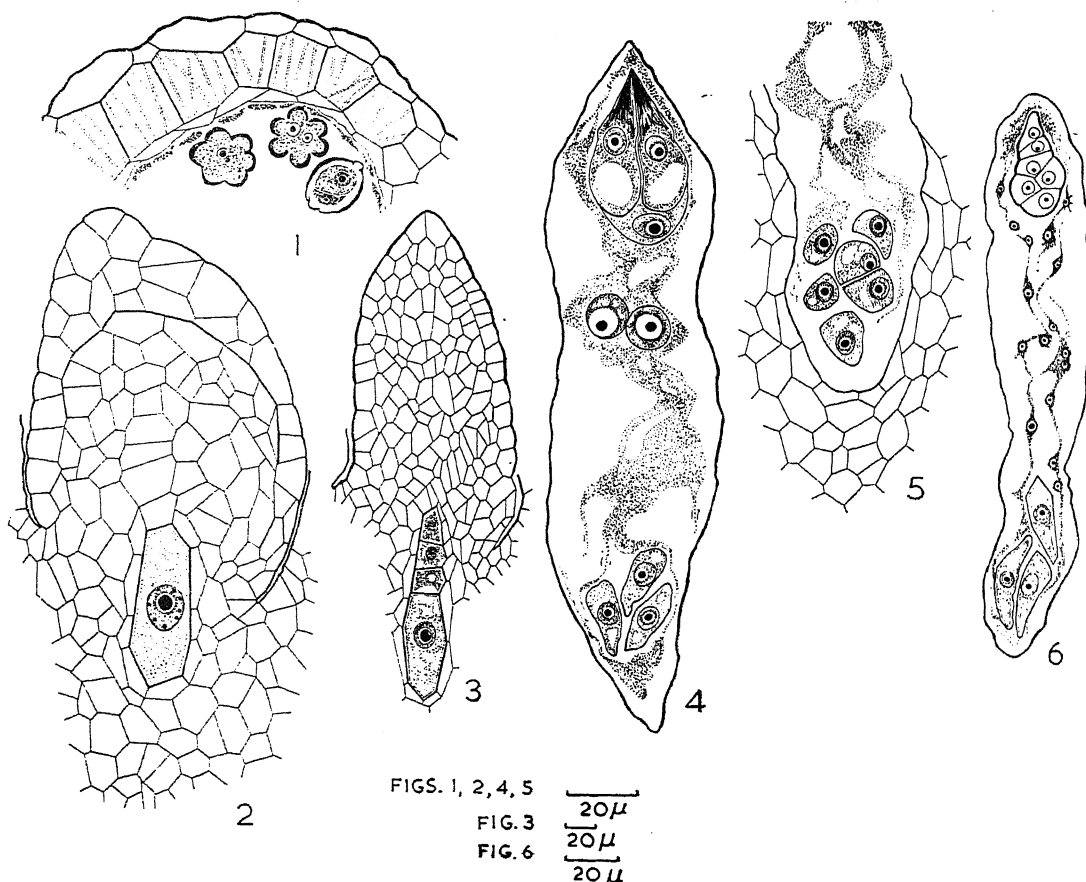
1. Maheshwari, P., *An Introduction to the Embryology of Angiosperms*, McGraw-Hill Book Co., New York, 1950.
2. La Rue, C. D., *Amer. J. Bot.*, 1947, **34**, 585.  
—, *Ibid.*, 1949, **36**, 798.
3. Lampton, R. K., *Thesis, Univ. Michigan Ann. Arbor*, 1952.
4. Pieczur, E. A., *Nature*, 1952, **170**, 241.
5. Sternheimer, Elizabeth, P., *Bull. Torrey bot. Cl.*, 1954, **81**, 111.
6. Straus, J. and LaRue, C. D., *Amer. J. Bot.*, 1954, **41**, 687.
7. Straus, J., *Ibid.*, 1954, **41**, 833.
8. Norstog, K. J., *Bot. Gaz.*, 1956, **117**, 253.

9. Tamaoki, T. and Ullstrup, A. J., *Bull. Torrey bot. Cl.*, 1958, **85**, 260.  
 10. Straus, J., *Science*, 1958, **128**, 537.  
 —, *Plant Physiol.*, 1959, **34**, 536  
 —, *Ibid.*, 1960, **35**, 645.

**SOME EMBRYOLOGICAL  
OBSERVATIONS OF GUIERA  
SENEGALENSIS LAM.**

As far as known, the African genus *Guiera*, belonging to the Combretaceae, has not been embryologically investigated. Hence the present study of *Guiera senegalensis* Lam., is undertaken.

of the secretory type with two-nucleate cells surrounding the rather extensive sporogenous tissue. The pollen mother cells divide in a simultaneous manner. Cytokinesis takes place by furrowing. The pollen tetrads are mostly of the tetrahedral type. The pollen grains, which are shed at the 2-celled stage, are ridged and furrowed and triporate. In the mature anther the epidermal cells become greatly stretched and flattened while the cells of the endothecium become radially elongated and develop the usual fibrous thickenings (Fig. 1).



FIGS. 1-6. Fig. 1. T.s. part of mature anther showing epidermis, endothecium with fibrous thickenings, middle layer, remnants of the tapetum and two-celled pollen grains. Fig. 2. L.s. nucellus showing megaspore mother cell, parietal tissue and nucellar cap. Fig. 3. L.s. nucellus showing the megaspore tetrad. Fig. 4. 8-nucleate embryo-sac. Fig. 5. Chalazal part of the ovule showing the 6 anti-podal cells. Fig. 6. Embryo-sac showing the proembryo, free nuclear endosperm and persisting anti-podal cells.

*Guiera senegalensis* is a shrub with flowers aggregated in dense globose heads. There are ten stamens in two whorls of five each. The structure of the anther shows the epidermis, endothecium, a middle layer and tapetum

The ovary is inferior and unilocular with three to five elongate, anatropous, bitegmic and crassinucellate ovules borne on apical placentae. The hypodermal archesporium is single-celled and cuts off a parietal cell which by further

divisions builds up an extensive parietal tissue. The nucellar epidermal cells also divide periclinally to form a nucellar cap (Fig. 2). The megaspore mother cell undergoes the usual meiotic divisions giving rise to a linear tetrad of megaspores (Fig. 3) of which the chalazal is functional. The development of the embryo-sac conforms to the Polygonum type. The mature embryo-sac consists of the usual three-celled egg apparatus, two polar nuclei and three to six antipodal cells (Figs. 4, 5). The antipodals are found to be persistent (Fig. 6), a feature not so far recorded for any of the investigated members.<sup>1-5</sup>

Observations made in respect of floral anatomy and embryology of a few other Combretaceae will be published elsewhere.

The author records his sincere gratitude to his teacher Prof. J. Venkateswarlu for guidance and constant encouragement and to Shri B. S. M. Dutt for helpful suggestions. His special thanks are due to the Director, Department of Forest Research, Ibadan, Nigeria, for kindly sending the material.

Department of Botany, P. S. PRAKASA RAO.  
Andhra University,  
Waltair, September 22, 1962.

1. Fagerlind, F., *Bot. Not. Lund.*, 1941, p. 217.
2. Karsten, G., *Biol. Bot.*, 1891, p. 22.
3. Mauritzon, J., *Lunds. Univ. Arsskrift. N.F. Afd.*, 1939, 2 (35), 1.
4. Nagaraj, M., *Curr. Sci.*, 1954, 23.
5. Venkateswarlu, J., *Phytomorphology*, 1952, 2, 231.

#### EFFECT OF AUXIN ON THE NATURE OF THE EMERGENCE OF LATERAL ROOTS IN *PHASEOLUS MUNGO* SEEDLINGS

HIGH concentration of auxin when applied to pre-imbibed seeds is known to cause an inhibition of the primary root growth and the emergence of many laterals giving the roots a bushy appearance.<sup>1-3</sup> In the normal growth of roots the root primordia of the laterals traverse obliquely downwards, or sometimes perpendicular, to the primary root axis and through the root cortex before it emerges as a lateral root.<sup>4</sup> A three hour's dip of pre-imbibed *Phaseolus mungo* var. T-2 seeds in 100 p.p.m. indole-3-butyric acid (IBA) solution showed a characteristic negative geotropic emergence of the lateral roots from its very inception as root primordia. The laterals emerged as a crown around the junction of the hypocotyl and the primary root which was considerably

swollen. Gibberellic acid, at the concentrations known to reverse the hypocotyl inhibition produced by auxin,<sup>5</sup> failed to alter this negative geotropic emergence of the laterals induced by auxin.

*P. mungo* seeds were soaked for six hours in distilled water. Batches of about 45 seeds, in batches of 15, were treated with 100 p.p.m. IBA and another identical set with 100 p.p.m. IBA + 5 p.p.m. of gibberellic acid. The seeds were treated for three hours. After the treatment the auxin solution was drained off and the seeds were washed thoroughly with distilled water. They were then transferred to acid-washed silica sand and moistened with water. The pots were supplied with water once a day. After 2-3 days of transfer the seedlings were dug out; they were washed in running tap-water and then fixed in formalin-acetic acid-alcohol mixture. The seedlings were dehydrated by passing through a series of grades of alcohol, alcohol-xylol mixtures and to xylol. After 2-3 days in xylol the seedlings were so transparent that the details of the vascular supply were clearly visible even to the naked eye. Whole mounts of these seedlings were prepared in Canada balsam and camera lucida sketches drawn.

Figure 1 shows the effect of IBA and IBA + gibberellic acid on the nature of emergence of the lateral roots.

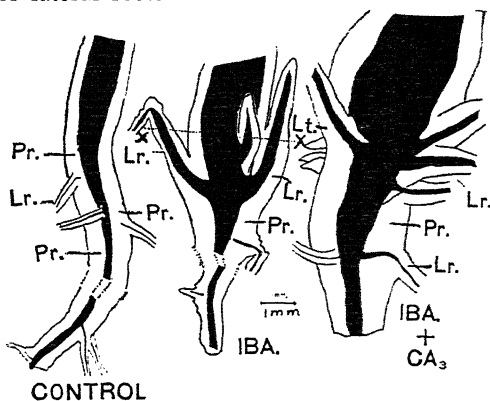


FIG. 1. Showing the behaviour of lateral roots in the IBA and IBA + GA<sub>3</sub> treated *Phaseolus mungo* seedlings. pr, primary root; Lr, Lateral root. X . . . . . X shows the plane of cross-section which gives intracortical root appearance.

It will be seen that while the control seedling shows the normal behaviour in that the laterals traverse obliquely downwards prior to their emergence, the laterals of the seedling treated with IBA were negatively geotropic. Gibberellic acid failed to counteract this effect.

The factors controlling the movement of laterals during their passage through the cortical tissue of primary root are still unknown although auxin regulation in the formation of intracortical roots of *Asphodelus tenuifolius* has been postulated.<sup>6</sup> It may be interesting to note that if a transverse section is cut through the 'X' axis in Fig. 1, the section gives a typical appearance of intracortical root system. The obvious difference in the two cases is that in the intracortical root system like that in *Asphodelus*, the laterals traverse a long way down in the root cortical tissues before it emerges; in auxin-treated *Phaseolus* seedlings it is due to an upward curvature of the emerging laterals. It may be that the concentration of auxin in the surrounding cortical tissue is the factor determining the passage of root laterals; high concentrations of auxin resulting into reverse passage of emergence.

Such a behaviour of the root laterals has not been reported for any other plant. In pea and oat which have been studied in greater detail profuse lateral formation has been reported but nothing concerning the nature of the emergence of lateral roots.<sup>1,2</sup> In bean 2, 4-D treatment produced swelling at the root-tip and all the laterals ran perpendicular to the primary root axis, and parallel to each other, traversing the cortical region of the primary root tissue.<sup>3</sup>

Our thanks are due to Professor R. N. Tandon for providing the necessary laboratory facilities and to Dr. Kurt Leben, Eli Lilly Company, U.S.A., for the gift of gibberellic acid. We wish to thank Dr. D. D. Pant for helpful discussions.

Botany Department, M. M. LALORAYA.  
University of Allahabad, V. K. RAI.  
Allahabad (India), July 11, 1962.

1. Thimann, K. V., *Amer. J. Bot.*, 1936, **23**, 561.
2. -- and Lane, R. H., *Ibid.*, 1938, **25**, 535.
3. Wild, M. H., *Ibid.*, 1951, **38**, 79.
4. Esau, K., *Plant Anatomy*, John Wiley & Sons, Inc., 1953, p. 498.
5. Laloraya, M. M. and Naqvi, S. A., *Science*, 1961, **133**, 1357.
6. Pant, D. D., *J. Indian Bot. Soc.*, 1943, **22**, 1.

### SANTALUM ALBUM AS A HOST TO CUSCUTA REFLEXA

THAT *Santalum album* is a root parasite is well established, due to the works of Scott, Barber and Rao. The other members of Santalaceae are also root parasites, some of them obligate parasites (Herbert, 1925). Self-parasitism in *Santalum album* is proved beyond doubt by Barber and Rao. Hosts of *Santalum album* have

been studied and listed by Barber, Rama Rao, Venkata Rao and Herbert; but none of these authors—some of them field officers of the Forest Department—have ever come across a *Santalum album* or any other member of the family being attacked by an angiospermous parasite. Even after extensive enquiries, so far as the author is aware of, no such root or stem parasite on *Santalum album* has been recorded. Razi (1957) in his search of various herbaria in U.S.A. for phanerogamic parasites from India and Pakistan has not found a single case of this type.

Along with his outdoor experiments to grow angiospermous parasites like *Viscum*, *Dendrophthoe*, *Cassiaetha*, *Balanophora* and *Orobanche*, the author tried to grow *Cuscuta* on Sandal without success. However, after several attempts and long trials, he was successful in growing *Cuscuta* sp. on *Santalum album*. The growth of *Cuscuta* on Sandal was very slow to begin with;—perhaps the parasite had to adjust itself to the host—but flourished very well later, heavily infecting the host plant (Fig. 1).



FIG. 1. A twig of the heavily infected *Santalum album* tree showing the parasite with the haustoria.

Studying the root haustoria of *Santalum album* in relation to mineral nutrition, Ramaiah, Parthasarathy and Rao (1962) state that..... all the elements tested for..... are found in the haustorium, specially located in the vascular strands, thus suggesting that these elements are being taken up by the Sandal from the host plant. However, the possibility of direct absorption also of these nutrients cannot be ruled out. In the light of the above, if the haustoria of a holo-parasite like *Cuscuta* are tested histo-



chemically, the possibility of direct absorption of nutrients from the soil is eliminated only the exchange picture between the host and the parasite will stand out prominent. *Cuscuta* on *Santal*, thus appears to be a good material for this type of work.

The anatomy of the haustorium, the host-parasite relation and the chemical contents of the adjacent tissues of the haustorium are being studied.

'Jaya Nivas',  
Gavipuram Extension,  
Bangalore-19, September 20, 1962.

L. N. RAO.

1. Fakler, C. A., *Mem. Dept. of Agri. in India*, 1906, 1 (2), Part 2.
2. Herbert, D. A., *Jour. Roy. Soc. Westn. Australia*, 1925, 11, 14.
3. Rao, L. N., *Ann. Bot. N.S.*, 1942, 6 (21), 131.
4. Rao, Rama M., *Indian Forester*, 1918, 44, 58.
5. Rao, Venkata, M. G., *Quarterly Jour. Mys. Forest Assoc.*, 1920, 3, 184.
6. —, *Ibid.*, 1921, 4, 88.
7. Kazi, B. A., *Lloydia*, 1957, 20 (4), 238.
8. Scott, J., *Bot. Ztg.*, 1874, 22, 129.
9. Ramaiah, P. K., Parthasarathy, K. and Rao, P. S., *Proc. Ind. Acad. Sci.*, 1962, 56B (2), 111.

## FLORAL ABNORMALITY IN COTTON

THE occurrence of certain floral abnormality in the bracteoles of cotton has been recorded by Annappan.<sup>1</sup>

The occurrence of floral abnormality in corolla and bracteoles of a Sea-Island Cotton is recorded.

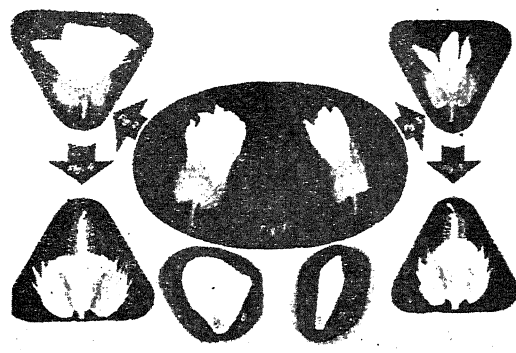
A sample of Sea-Island Cotton-seeds, received from the Director of Agriculture, Kerala, for trial, was grown in the Botany Division and in one of the plants two types of flowers were noticed in 1961. The plant was normal and healthy and produced normal flowers. But in one of the axillary branches a type of flower, which was conspicuously different from the normal one, was observed. Such abnormal flowers also developed normal fruits and seeds. The two types of flowers borne on the same plant are shown in Fig. 1.

The variation observed was only in the corolla and the bracteoles. The petals of the abnormal flower were narrow, thicker, longer and deeper in colour than the petals of the normal flower (Figs. 3 and 7).

Normally the petals of cotton are free up to the base where they fuse with the staminal tube, but in the abnormal flower the petals

were free only up to their two-third's length (Fig. 3).

The bracteoles of the abnormal type were normal in size and shape but on the inside of the involucre there were three small, green,



FIGS. 1-7

scale-like structures which were absent in the normal type (Figs. 3 and 5). All other floral parts, viz., style, stigma, anther, staminal tube; ovary and ovule resembled those of the normal flower (Figs. 2, 3, 4 and 5).

The author's thanks are due to Prof. L. S. S. Kumar, Dean and Additional Director for Research, for his valuable guidance during the course of the work.

Agri. College and R.I., P. KUMARA PILLAI,  
Vellayani, Kerala (India),  
July 18, 1962.

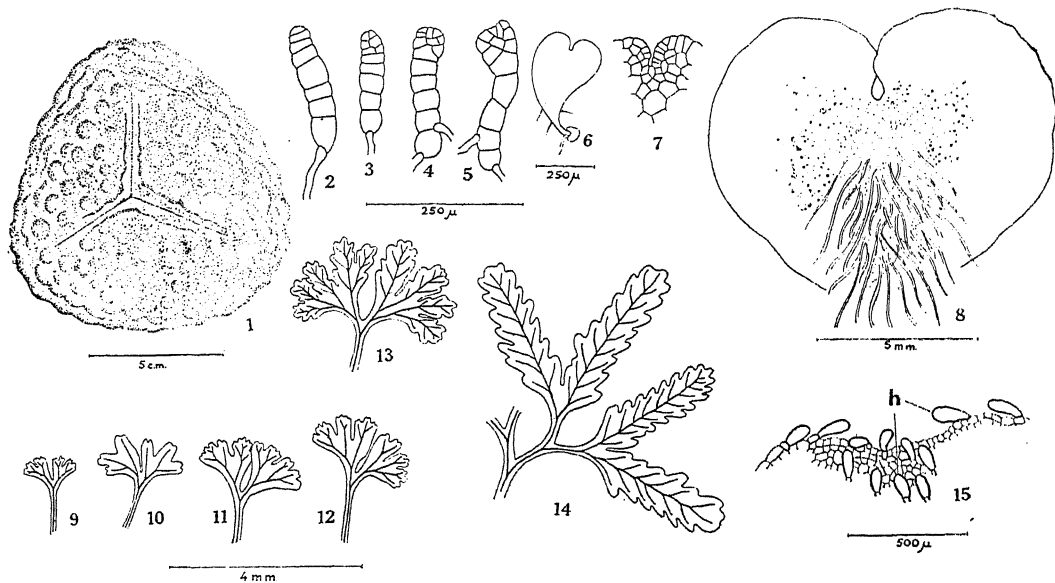
1. Annappan, R. S., *Madras Agri. J.*, 1960, 47 (12), 519.

THE GAMETOPHYTES OF *LYGODIUM*  
*CIRCINATUM* (BURM.) SW. AND  
*L. FLEXUOSUM* (L.) SW.

*Lygodium* is a small genus of Schizæoid ferns characterised by the long climbing nature of the leaves. Four species are reported from India.<sup>2</sup> Even though the morphology of sporophyte of *Lygodium* is rather well known<sup>3</sup> the morphology of spores and prothalli seems to have attracted little attention. A few details are described by Bauke,<sup>1</sup> Heim<sup>5</sup> and Stokey.<sup>8</sup> The present study deals with *Lygodium circinatum* and *L. flexuosum*. Spores of *L. circinatum* were collected from Andaman Islands and those of *L. flexuosum* from N.-E. India. Spore morphology is studied from acetolysed preparations mounted in glycerine jelly<sup>4</sup> and the measurements are based on ten readings in each plane of the spores. Morphology of the prothalli is based entirely on laboratory cultures, raised on nutrient agar medium maintained at a temperature of  $23 \pm 2^\circ \text{C}$ . and a light intensity of 600 ft.-c.<sup>7</sup>

nate with the lips having wavy margins. The exine is nearly  $7\mu$  thick, demarcated into a thin endoexine and a thick ectoexine bearing irregularly shaped, wart-like protuberances which are densely distributed to form an areolate pattern.

The spores of both the species studied retain viability for long, and on sowing germinates within a fortnight. The germ filament (Fig. 2) generally becomes five or six cells long before the anterior cells undergo longitudinal divisions initiating the formation of a prothallial plate. The cells of the germ filament are generally barrel-shaped or disc-shaped, but under crowded conditions some of them, especially basal ones, elongate. The terminal cell soon divides longitudinally by a vertical wall, followed by another division in one of the daughter cells by a wall oblique to the vertical wall, resulting in a medianly placed obconical meristematic cell (Figs. 3, 4). The prothalli grow very rapidly after the formation of an apical meristematic cell and a broad, notched, multicellular apex



FIGS. 1-15. Fig. 1. Proximal view of the spore of *L. flexuosum*. Figs. 2-7. Stages in development of the prothallus. Figs. 2, 3, 5: *L. flexuosum*; Figs. 4, 6, 7: *L. circinatum*. [Fig. 8. Mature prothallus of *L. circinatum*. Figs. 9-14. Juvenile leaves of *L. flexuosum* showing succession of venation pattern and lobing of lamina. Fig. 15. A portion of the margin of the juvenile lamina of *L. flexuosum*, showing marginal and superficial hairs (h).]

The spores of *L. circinatum* and *L. flexuosum* (Fig. 1) are trilete (tetrahedral), triapsidate (triangular with rounded corners and convex sides) in equatorial view, sub-circular in polar view and measuring on an average  $80-85 \times 90-100 \mu$  (P  $\times$  E). The læsura is crassimargi-

is developed by successive divisions of the meristematic cell in two to four days (Figs. 5-7). The prothallus soon becomes cordate, with the meristematic cell located at the bottom of a deep apical notch. The apical meristematic cell is replaced later by a multicellular meristem

in the usual way and the prothalli attain maturity in fifty to eighty days (after spore germination). The mature prothallus (Fig. 8) is massive, cordate, ca. 0.5 to 0.7 cm. across and naked. The midrib is broad and generally 8-12 cells thick. The wing cells are uniformly thin-walled.

The first leaf of the young sporophyte of *L. circinatum* and *L. flexuosum* is flabellate in plan. The lamina is broadly cuneate and deeply dissected into two halves by a terminal notch (Figs. 9, 10). The two segments are often further lobed in a dichotomous manner. The single vein entering the lamina forks three or four times. In the succeeding leaves the lamina becomes bigger but its shape and venation pattern remains almost the same (Figs. 11, 12). In the fifth or sixth leaf the venation becomes pinnate in the secondary segments of the lamina and the segments elongate considerably, developing pinnately lobed margins, the lobations corresponding to the lateral veins (Fig. 13). This form of the juvenile leaf persists for long (Fig. 14), some of the juvenile plants collected from nature having the lamina over 30 cm. each way. All juvenile leaves bear small club-shaped hairs over the margins and both the sides of lamina. Hairs are two-celled, with a club-shaped terminal cell and a small stalk cell which is partially embedded among the epidermal cells of the lamina (Fig. 15). These hairs resemble the type of prothallial hairs reported in *Anemia*.<sup>5,8</sup>

I am indebted to Professor K. N. Kaul, Director, for his keen interest in this work and to Dr. B. K. Nayar, for his help and guidance.

Pteridology Laboratory, PRAKASH CHANDRA,  
National Botanic Gardens,  
Lucknow (India), July 17, 1962.

1. Bauke, H., *Jahrb. f. Wiss. Bot.*, 1878, **11**, 603.
2. Beddome, R. H., *Ferns of British India*, 1892.
3. Bower, F. O., *The Ferns*, 1923-28.
4. Erdtman, G., *Pollen Morphology and Plant Taxonomy*, Stockholm, 1952.
5. Heim, C., *Flora*, 1892, **82**, 329.
6. Kaur, S., *Sci. and Cult.*, 1961, **27**, 347.
7. Nayar, B. K., *Bot. Gaz.*, 1962, **123**, 223.
8. Stokey, A. G., *Phytomorphology*, 1951, **1**, 39.

#### OCCURRENCE OF A BRANCHED OVIDUCT IN *PANULIRUS* *POLYPHAGUS*

ONE of the specimens of spiny Lobster (*Panulirus polyphagus* Herbst, Crustacea—Decapoda: Family—Panuliridae) given for dis-

section work, was observed to have an abnormality in the reproductive system.

Left oviduct was normal, but the right oviduct was bifurcated a little farther away from its origin. One of the branches as usual opened in the coxopodite of the third leg, but the additional branch entered blindly into the muscles of the coxopodite of the fourth leg (Fig. 1).



FIG. 1. Photograph of reproductive system (Mounted) of *Panulirus polyphagus* showing additional oviduct.

Biology Department, E. S. BARAIYA,  
St. Xavier's College,  
Ahmedabad, July 1962.

#### INFLUENCE OF HYDROGEN-ION CONCENTRATIONS ON THE UTILIZA- TION OF SODIUM NITRITE BY *DIPLODIA TYPHINA* SACC. AND *BOTRYODIPLODIA THEOBROMAE* PAT.

RESEARCHES of various investigators including Ajello,<sup>1</sup> Gordon,<sup>2</sup> Cochrane<sup>3</sup>; Cochrane and Conn,<sup>4</sup> Tandon and Bilgrami,<sup>5</sup> as well as Chandra<sup>6</sup> indicated the toxic effect of nitrite nitrogen to various fungi. Toxicity of this anion is closely related to the pH of the medium and is greater in the acidic medium. In the present investigation a detailed study was undertaken to study the effect of pH on the utilization of sodium nitrite by *Diplodia typhina* and *Botryodiplodia theobromae*. For this purpose potassium nitrate of Asthana and Hawker's medium A was replaced with 2.39 g. of sodium nitrite and thus the amount of

nitrogen was similar to that present in Asthana and Hawker's medium A. The medium was adjusted to different pH with the help of N/10 HCl and N/10 KOH. Both the organisms were allowed to grow at  $25^{\circ} \pm 1^{\circ}$  C. for 15 days and the dry weight results are summarized in Table I.

TABLE I

Showing the dry weight of *D. typhina* and *B. theobromæ* at different pH

Initial pH	<i>Diplodia typhina</i>		<i>Botryodiplodia theobromæ</i>	
	Dry weight in mg.	Final pH	Dry weight in mg.	Final pH
2.5	0.0	2.5	0.0	2.5
3.2	0.0	3.2	0.0	3.2
4.2	0.0	4.2	0.0	4.5
5.2	0.0	5.2	0.0	5.2
6.1	19.6	6.8	16.4	7.0
6.8	35.2	7.3	37.9	7.5
7.6	49.3	8.2	49.7	8.5
8.5	31.2	8.0	28.6	7.8
9.0	16.6	8.6	18.7	8.5

Table I indicates that both the fungi could not grow in the medium adjusted to pH 2.5, 3.2, 4.2 and 5.2 but they grew at higher pH. Optimum growth of both these organisms was at pH 7.6. Their growth was less at pH 6.2 and 9.0. Due to metabolic activities the pH of the media originally adjusted up to 7.6 increased while there was a slight decrease in the case of those adjusted to 8.5 and 9.0.

It is thus quite evident that nitrite was toxic in the acidic medium only, where nitrites were in the form of undissociated nitrous acid. This result appears to be in conformity with the findings of Cochrane<sup>3</sup>; Cochrane and Conn<sup>4</sup> and Nord and Mull.<sup>7</sup> Utilization of sodium nitrite in alkaline media finds support from the work of Brock,<sup>2</sup> Tandon and Agarwal<sup>8</sup> and Thind and Duggal.<sup>10</sup> Efficient utilization of sodium nitrite at higher pH appears to be due to the fact that the formation of nitrous acid, which has toxic effect, is prevented under such condition.

Both the organisms were originally isolated by Dr. K. S. Bilgrami. The authors are grateful to him for placing them at their disposal for detailed studies.

Botany Department, R. N. TANDON.  
University of Allahabad, M. P. SRIVASTAVA.  
Allahabad, October 30, 1962.

1. Ajello, L., *Amer. Jour. Bot.*, 1943, **35**, 135.
2. Brock, T. D., *Mycologia*, 1951, **43**, 402.
3. Chandra, S., *D.Phil. Thesis*, Allahabad University, 1961.

4. Cochrane, V. W. and Conn, J. E., *Bull. Torr. Bot. Club*, 1950, **77**, 10.
5. —, *Ibid.*, 1950, **77**, 176.
6. Gordon, M. A., *Mycologia*, 1950, **42**, 167.
7. Nord, F. F. and Mull, R. P., *Advances in Enzymol.*, 1945 **5**, 165.
8. Tandon, R. P. and Agarwal, G. P., *Proc. Nat. Acad. Sci. (India)*, 1953, **23**, 179.
9. Tandon, R. N. and Bilgrami, K. S., *Ibid.*, 1957, **27 B**, 269.
10. Thind, K. S. and Livlin Duggal, *Curr. Sci.*, 1957, **26**, 293.

## NOTE ON INDUCTION OF FLOWERING IN TRAILING SHOOTS OF CLONES OF *SACCHARUM SPONTANEUM*

AMONG the collections of *S. spontaneum* maintained at the Institute, about 75 clones, predominantly of Indian origin, are observed to put forth long trailing shoots along with the normal erect and semi-erect shoots. These trailing shoots remain purely vegetative throughout their life with a considerable reduction in the size of their successive blades and the buds at almost each and every node sprouting instead of remaining dormant as is observed in the normal erect shoots. They are further characterised by a very fast growth-rate. While the erect and semi-erect shoots in these clones flower rather profusely, the trailing shoots always remain vegetative. It was thought worthwhile to find out whether such purely vegetative trailers could be induced to flower by keeping them erect. The observation of Mangelsdorf<sup>1</sup> that erect stalks are more likely to tassel than the recumbent ones is a pointer in this direction. An earlier study conducted by Panje<sup>2</sup> in this regard with 30 clones resulted in very limited success. Negi and Mishra<sup>3</sup> observed that in the lodging forms of *S. spontaneum* which assume a trailing habit, flowering was very sparse and bulk of the stalks in the clump continued their vegetative phase and showed no trace of floral primordia.

Seven Indian clones of *spontaneum* were selected for the study. Towards the end of August, just before floral initiation is known to take place, five well-grown trailing shoots in each of the above seven clones were kept erect by tying them vertically against tall bamboo poles, and the five control shoots were allowed to trail on a horizontally placed bamboo to prevent nodal rooting. Particular care was taken to see that the apex of the erected trailing shoots was always vertical.

Flowering was observed during November-December in some of the treated shoots while there was no sign of flowering in the control

shoots. Of the seven clones tested, flowering was observed in respect of five, while in the other two clones (SES 147 B and 160 B) there was no indication of flowering. Photographs taken in respect of the four clones are presented in Figs. 1 to 4.

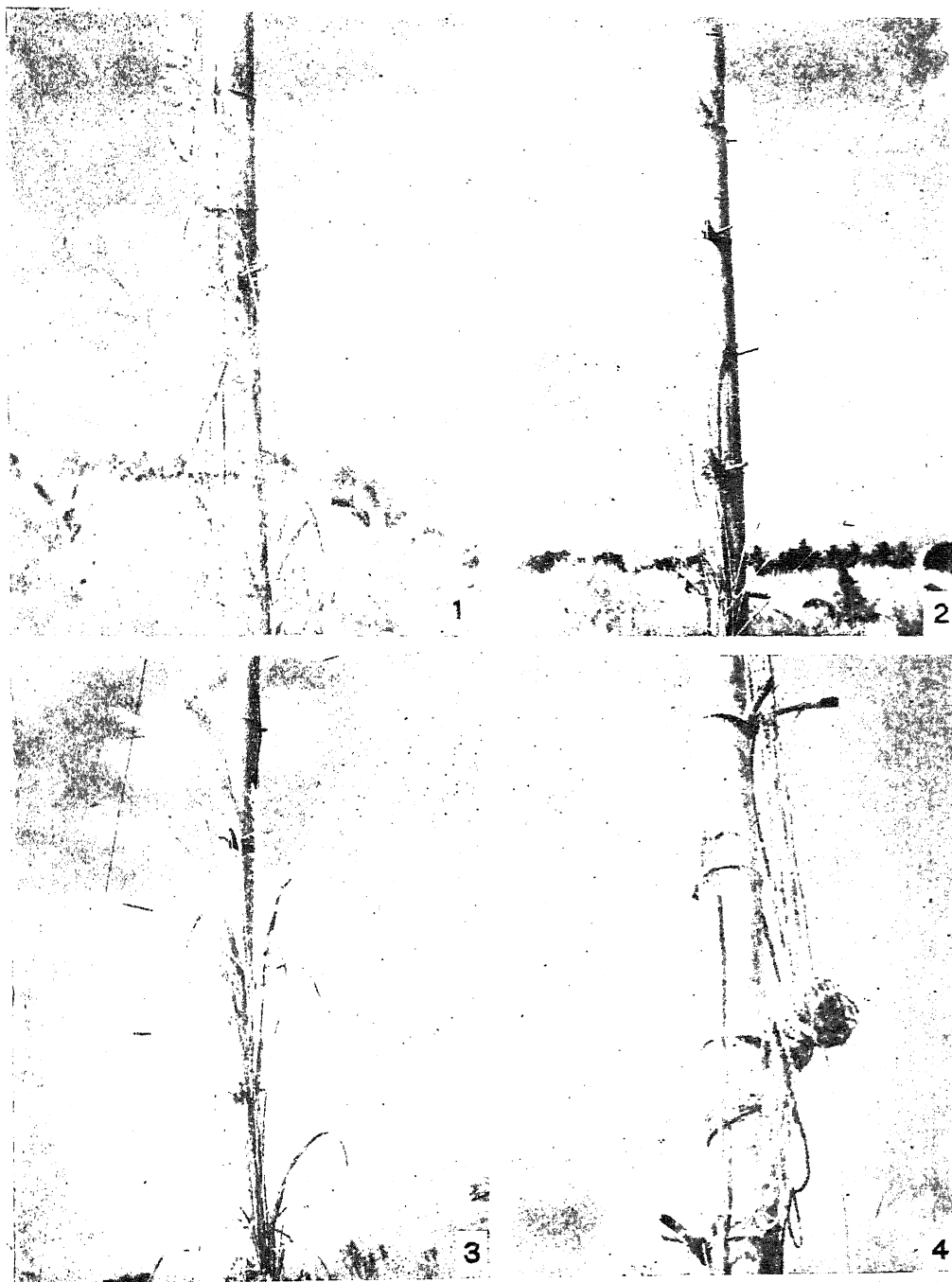


FIG. 1. Flowering in trailing shoots of clones : (1) SES-116 A, (2) SES-121 A, (3) SES-275, (4) SES-375.

other two clones (SES 147 B and 160 B) there was no indication of flowering. Photographs Data were gathered of the dimensions of the shoot and leaf blade and time of flowering on

culms under treatment as also the control shoots. From the data it is evident that: (i) there is a definite inducement of flowering when the trailing shoots are kept erect; (ii) a delay of approximately one month is discernible in the time of flowering of the erected trailing shoots as against the normal semi-erect shoots; (iii) the growth of the trailing shoots gets retarded when erected and (iv) in the matter of blade length, the treated shoots record greater values than the control. This indicates that when the trailing shoots change from vegetative to the reproductive phase, there is an exaggeration in the dimensions of the blade.

Thanks are due to Dr. J. Thuljaram Rao, Director, for encouragement.

Sugarcane Breeding Inst., K. SRINIVASAN.

Coimbatore-7,

M. B. G. R. BATCHA.

July 11, 1962.

1. Mangelsdorf, A. J., *Proc. Int. Sec. Sugarcane Technol.*, 9th Cong., 1956, p. 560.
2. Panje, R. R., *Annual Report of the Spontaneous Expedition Scheme*, Sugarcane Breeding Institute, Coimbatore, 1952-53.
3. Negi, O. P. and Mishra, D. N., *Ind. Jour. Sug. Res. and Dev.*, 1960, 4, Pt. 4.

#### STERILITY IN PEARL MILLET (*Pennisetum typhoides* STAFF AND HUBB)

MALE STERILITY in *Pennisetum typhoides* has been reported earlier by Burton,<sup>1</sup> Kajjari and Patil<sup>2</sup> and Menon<sup>3</sup>; the nature of sterility in the former case was probably genic and in the latter two cases cytoplasmic. As far as the authors are aware, female sterility in this species has not been reported.

An almost seed sterile plant was detected from amongst the population of *P. typhoides* raised from open pollinated seeds during the normal kharif season of 1961. On closer examination it was observed that there was complete suppression of anther development and to a large extent poor development of stigma. Unlike in normal cases the emergence of the stigmas was only partial. Cytological examinations revealed the failure of microsporogenesis, mitotic behaviour, however, being normal. On profuse hand pollination of available ten ears borne on subsequent tillers hardly 10 seeds were obtained, whereas a few thousand seeds could be obtained from the corresponding number of ears from a normal *typhoides* plant. This confirms almost complete female sterility in the plant under report. This, therefore, constitutes

the first record of male and female sterility in one and the same plant of *Pennisetum typhoides*.

The few seeds that were obtained by profuse pollination were sown. Only three plants germinated and reached maturity and were available for study. The detailed observations on these plants revealed that as far as sterility was concerned, all the three plants were again sterile on the male as well as female side. They, however, differed from each other in respect of some of the morphological characters like leaf hairiness, anthocyanin pigmentation and size of the plant parts. Such differences in the progeny for morphological characters rule out the possibility of apomictic reproduction. The persistence of sterility in the progeny indicates that this character may be extra-nuclear in inheritance.

Division of Botany,

Indian Agricultural

Research Institute,

New Delhi-12, June 13, 1962.

B. D. PATIL.

M. G. JOSHI.

1. Burton, Glenn, W., "Cytoplasmic male sterility in pearl millet (*Pennisetum glaucum*)," *Agr. n. Jour.*, 1958, 50 (4), 230.
2. Kajjari, N. B. and Patel, J. A., "A male sterile bajri," *Ind. Jour. Genet. Pl. Breed.*, 1956, 2 (16), 146.
3. Menon, Madhawa. P., "Occurrence of Cytoplasmic male sterility in pearl millet," *Curr. Sci.*, 1959, 28 (4), 165.

#### ISOLATION OF A SPECIES OF LICEA AND THE STUDY OF ITS PLASMODIUM UNDER CULTURAL CONDITION

PLASMODIUM of a Myxomycete, isolated from decayed leaves of *Lagenaria vulgaris* Ser, was successfully grown on agar medium under laboratory condition. Detailed study of the plasmodial characteristics was made and the plasmodial activity was followed up to fruiting stage.

*Cultural characteristics of the plasmodium.*—Isolation of the organism in the plasmodial stage was fairly easy as there was not much of bacterial association with the plasmodium. With frequent changes of the medium a bacteria-free plasmodium was isolated. Rapidity of the plasmodial movement was found to be directly related with the moisture content of the medium. Best movement was recorded at 2.5% agar medium under diffused light. When exposed to strong light and grown in high moisture content, the plasmodium receded rounding up without showing any sign of movement. But it regained its normal condition when put under diffused

light and grown in the medium having correct moisture content.

*Characters of the plasmodium.*—The watery, white coloured plasmodium could be differentiated broadly into three regions. The most actively progressing fan region where the protoplasmic movement was very rapid—the zone of formation; just behind it, a less active transition region where the protoplasmic movement was not that rapid and the plasmodial portion forming reticulum—the zone of reticulum; and finally a comparatively mature region with no visible protoplasmic movement—the zone of maturation, this part of the plasmodium was tube-like in appearance. Overall, the plasmodial

diocarps were transformed into fertile spores with complete absence of any capillitium. There is no trace of lime granules in the fructifications. The spores are light brown in colour having dimension ranging from  $12\mu$  to  $14\mu$  in diameter with uniformly thick wall.

The Myxomycete under investigation is identified as one of the species of the genus *Licea* for the following characters:

Sporangia forming dark-coloured sessile and scattered plasmodiocarps with cartilaginous wall; absence of capillitium and lime granules; spores light brown coloured with uniformly thick wall; spore dimension ranging from  $12\mu$  to  $14\mu$  in diameter.



FIG. 1. A group of plasmodiocarps.  $\times 6$ .

movement was seen to be very vigorous all the time and along with the movement it left behind, a prominent trail.

*Sporangial development.*—After crawling for quite a long time, with starvation, certain part of the plasmodium started to form protoplasmic blobs on the surface of the medium which were ultimately transformed into dark-coloured sporangia. The rest of the plasmodium moved forward and was transformed into sporangia of very variable shape keeping some resemblance with the branches of the plasmodium (Fig. 1). Sessile fructifications of plasmodiocarpic in nature with smooth surface having cartilaginous wall were formed. The contents of the plasmo-

Mycology and Plant  
Pathology Laboratory,  
Presidency College,  
Calcutta, July 26, 1962.

ASOK KR. KAR.

1. Butler, E. J. and Bisby, G. R., *The Fungi of India*. Revised by R. S. Vasudeva, Indian Council of Agricultural Research, New Delhi, India, 1954.
2. Das Gupta, S. N., *History of Botanical Researches in India, Burma and Ceylon*, Part I. Mycology and Plant Pathology, *Indian bot. Soc.* Special Publication, 1958.
3. Lister, A., *A Monograph of the Mycetozoa*, Ed. 3. Revised by G. Lister, British Museum (Natural History), London, 1925.

IN THOUGHT, IN WORD AND IN DEED  
SERVE INDIA

---



---

## REVIEWS

---



---

**Table of Sines and Cosines to Ten Decimal Places at Thousandths of a Degree.** By H. E. Salzer and N. Levine. (Pergamon Press, Headington Hill Hall, Oxford), 1962. Price 70 sh.

The use of the decimal subdivision of the degree, instead of minutes and seconds, has been found to be more convenient in a number of computational problems in applied mathematics, especially those connected with the various aspects of space research and technology. The present publication of about 900 pages, gives the sines and cosines correct to ten decimal places of angles at thousandths of a degree. Sines and cosines are given side by side on the same page and in each entry all the ten digits are explicitly given.

This *Table* will meet the demand where such accuracy is needed in the application of these two trigonometrical functions.

There is an errata slip which contains only two corrections of significance. This shows that the *Tables* have been prepared very carefully.

---

**Dispersion Relations and the Abstract Approach to Field Theory.** Edited by Lewis Klein. (Gordon and Breach, Science Pub. Inc., 150, Fifth Avenue, New York 11; N.Y.), 1961. Pp. x + 273. Price \$ 4.95.

This volume, the first of the International Science Review Series published by Gordon and Breach, contains a selection of fifteen original papers on field theory by authors who are chiefly responsible for its formulation and growth. These papers appeared in various scientific journals between the years 1954 and 1960. In the selection of papers an attempt has been made to give the interested reader a coherent picture of the origin of the theory, the initial difficulties encountered in its development, the knowledge it has added to our understanding of the physics of elementary particles and the outlook for the future of the theory.

The papers may be divided into two groups, namely, the first group of seven giving the axiomatic approach of the subject and the second group of eight papers concerned with the application of the abstract formulation to the problem of providing dispersion relations. Among the contributors are H. Lehmann, K. Symanzik, W. Zimmermann, A. S. Wightman,

R. Haag, H. J. Bremermann, J. G. Taylor, F. J. Dyson, S. Mandelstam, I. Pomeranchuk and S. Gasiorowicz.

As the Editor Lewis Klein says in the Preface the selection of papers would present a survey of the fundamental physical ideas and mathematical techniques adequate to permit the reader to become conversant with this new and rapidly changing field of physics.

---

**Introductory Atomic Physics.** By M. R. Wehr and J. A. Richards. (Addison-Wesley Publishing Co., Inc., Reading, Mass.), 1962. Pp. xi + 420. Price \$ 6.50.

This book closely follows the authors' book *Physics of the Atom* published earlier. The chief difference between the two books lies in the mathematical level, the present one requiring on the part of the student only an elementary background knowledge of trigonometry and not calculus. The book will form a good introduction to modern physics to the degree students of Indian Universities. It includes amongst other topics, solid state physics, nuclear energy and nuclear reactors, cosmic radiation and fundamental particles. At the end of each chapter there are elementary problems to stimulate interest in the understanding of the text.

---

**Theoretical Electromagnetism.** By R. H. Atkin. (M/s. William Heinemann, 15-16, Queen Street, London W. 1), 1962. Pp. vii + 260. Price 30 sh.

The author's two previous books *Mathematics and Wave Mechanics* and *Classical Dynamics* have been well received by University students of mathematics and physics, and there is no doubt that the present volume on *Theoretical Electromagnetism* will also appeal to the more serious-minded students. It can be used as a subsidiary text-book in Electricity and Magnetism for the Pass and Honours Courses in Physics in Indian Universities. It assumes on the part of the student who uses it a good knowledge of the fundamentals of vector field theory, complex functions, tensor theory and its matrix representation.

There are six chapters in the book dealing respectively with electrostatics, magnetostatics, current electricity, electro-magnetism, Maxwell's field equations, and special theory of relativity.



The fundamentals of the theory and the important theorems are explained in a concise, but at the same time clear, way in the beginning of each chapter; then follow a large number of worked problems which have been carefully selected to cover every aspect of the theory for a correct understanding of the subject. Finally, at the end of each chapter there are exercises which comprise questions selected from papers set in the university examinations of Cambridge, Oxford and London.

The above-mentioned features of the book will be of special value to university students as they will satisfy their examination requirements in this subject.

---

**Radical Polymerisation.** By J. C. Bevington. (Academic Press, New York and London), 1961. Pp. viii + 185. Price 40 sh.

After a general introduction followed by a chapter on methods of production of radicals, the various component steps in addition to polymerisation, *e.g.*, initiation; propagation, chain transfer, termination, inhibition and retardation are discussed in separate five chapters. Results of extensive researches in the field are examined critically and salient features summarised. The admirable scope which a study of vinyl polymerisation kinetics offers to draw general conclusions illustrative of the varying reactivities of radicals and types of radical reactions generally, is also well utilised. The treatment is concise avoiding derivations of detailed kinetic equations and is hence likely to be most useful to the polymer chemist already familiar with radical polymerisation, while others may find difficulty in many places. Choice of data and figures presented is more illustrative than comprehensive. The emphasis of course varies throughout the book and some parts like copolymerisation are rather loosely treated. There is a good account of the application of radioactive isotopes to elucidate the reacting and reactivities of radicals in the polymerising systems, especially those from labelled initiators and as is well known the author's own contributions in this field are notable. It is rather surprising to find that living polymers are incorrectly described as being produced by sodium naphthalene by a 'Cationic mechanism' (p. 26).

References are grouped at the end of the book and names of authors and years of publications are given as codes in the body of the book. This system certainly increases the difficulty of the reader and must be considered as a drawback. It is however an up-to-date compilation of all

the important research papers in this field published up to mid 1960.

Get-up and printing are excellent. The book should be useful to the specialist as a refreshing review of some significant advances in radical polymerisation.

S. L. KAPUR.

---

**Techniques for Electron Microscopy.** Edited by Desmond Kay. (Blackwell Scientific Publications, Oxford), 1961. Pp. xvii + 331. Price 63 sh.

Rapid strides have been made in recent years in the application of the electron microscope to diverse fields of scientific study, particularly biology and metallurgy. The well-known volume on "The Practice of Electron Microscopy" edited by Drummond in the fifties has gone out of print and the need for an up-to-date successor to it has been felt keenly for some time. The present book is, therefore, bound to be welcomed by all interested in the use of the electron microscope.

The volume contains a comprehensive treatment of all electron-microscopic techniques by seven different contributors. There are also chapters on the operation of the electron microscope, the ancillary apparatus and special attachments. Every chapter is written by one or more experts in the respective field, *viz.*, Agar and Horne on instruments, Bradley on replica, Glauert on biological preparations and Phillips on thin metal foils. A very useful feature of the book is the two-page appendix giving names and addresses of suppliers of special materials and apparatus for electron-microscopic work.

It can safely be predicted that this most attractively got-up volume will become a handbook to electron microscopists all over the world.

T. R. ANANTHARAMAN.

---

**Surface Phenomena in Metals and Alloys.** By V. K. Semenchenko, Translated from Russian by N. G. Anderson and edited by R. Kennedy. (Pergamon Press, Ltd., Oxford, London and New York), 1961. Pp. xx + 466. Price 105 sh. (\$ 17.60).

This book is based on the active research and development work of the author and his Russian colleagues in the last decade on surface and interfacial phenomena in liquid and solid metals and alloys. The editor, the translator and the publishers are all to be congratulated for making this book available to readers in English in

quick time through the photo-lithographic production method.

The treatment of theoretical and experimental data by the author is most comprehensive. Most of the standard expressions have been derived and a number of general formulæ also obtained in connection with experimental measurements of surface equilibria. Experimental techniques have been critically analysed and data for pure metals and metallic solutions have been extensively given.

This book is a notable addition to the library on surface physics and can be recommended to specialists as well as students on this subject.

T. R. ANANTHARAMAN.

**Cerebral Sphingolipidoses.** (*A Symposium on Tay-Sachs' Disease and Allied Disorders.*) Edited by S. M. Axonson and B. M. Volk. (Academic Press, New York), 1962. Pp. xvii + 456. Price \$ 18.00.

Sphingolipidoses are hereditary diseases in which there is an accumulation of sphingolipids in one or more tissues of the body. Tay-Sachs' disease (infantile amaurotic idiocy), Niemann-pick disease and Gaucher's disease are well-known examples of this class. More extensive application of modern diagnostic techniques has enabled the identification of a host of neural, neurovisceral and purely visceral lipidoses and of diseases which may closely simulate them. These fatal disorders have not yet been systematically investigated and considerable confusion exists in descriptive clinical manifestations and in the quantisation of the biochemical derangements, specific for each type of disease.

This manual, presenting the papers of the symposium on Tay-Sachs' disease and allied disorders, highlights the salient features of the sphingolipidoses in general and of some specific disorders in particular.

Profound astrocytosis and supratentorial megalocephaly, the accumulation of granules of lipid resembling neuronal lipofuscin, electron microscopic observations on the fine structure of abnormal nervous tissue cytoplasm and the nature of vacuolised blood lymphocytes in Tay-Sachs' disease depict interesting development in the study of this vaguely understood disease.

"Concepts of dysmyelination and leucodystrophies" and the chemical nature of sphingolipids focus attention of the existence of close interrelationship in these diseases.

The biochemical attack, too, is well reflected in the chapters on 'improved procedures for the determination of lipid phosphorus in tissues;

fractionation of complex lipid mixtures by chromatography; isolation and characterization of new gangliosides in Tay-Sachs' disease; the cationic interaction of strandin and its biological functions and the lipid analysis of cerebrospinal fluid and serum from patients of proven sphingolipidoses.'

The comprehensive documented reports of Tay-Sachs' disease depict the epidemiological and genetic aspects of these hereditary diseases.

M. SIRSI.

**Cell Mechanisms in Hormone Production and Release.** (*Memoirs of the Society for Endocrinology*, No. 11.) Edited by P. C. Williams and C. R. Austin. (University Press, Cambridge), 1961. Pp. x + 171. Price 40 sh.

This eleventh number of the *Memoirs of the Society for Endocrinology* covers the proceedings of a symposium held in May 1960. The central theme of the symposium was the role of hormones in cellular metabolism. Fifteen invited speakers made contributions on various aspects of the relationship between cell mechanisms and hormone production and action. Two papers by S. F. Jackson and L. Weiss, dealt with the newer knowledge of Cell structure, available especially through Electron microscopy. The effects of hormones were dealt with in several papers, by A. C. Allison, P. N. Campbell and A. Korner. The metabolism of thyroid hormones formed part of two papers, by R. Pitt-Rivers and J. R. Tata. The effects of hormones and especially the modes of their action have formed the subject-matter of several papers, of which those by Howard Smith, Battaglia, Emmens and Reid are important.

The symposium does not cover the whole field of hormones and cellular metabolism. Nevertheless it serves to focus attention on the basic mechanisms of hormonal action on cell structure and cell function.

B. R. S.

**The Algae.** By V. J. Chapman. (Macmillan and Co., London), 1962. Pp. 472. Text-Figures 229. Price 32 sh.

The book succeeds the author's earlier publication *An Introduction to the Study of Algae* with addition of fresh material. In this book he follows the type method of instruction used by him earlier in dealing with individual orders, and families. He had included chapters which provide a survey of many aspects of algae which may be of great use for the undergraduate

student in his efforts to get an overall picture of the biology of algæ.

The book is divided into a number of chapters on Classification, History, Euphycophyta, Chrysophycophyta, Pyrrophycophyta, Myxophycophyta; Reproduction and Evolution, Ecology of Rocky Coasts, Ecology of Salt Marshes, Freshwater Ecology and Soil Algæ, Ecological Factors, Physiology including Symbiosis, Geographical Distribution and Life Forms, and lastly on the Utilization of Algæ. Euglenophyta are conspicuous by their absence in the earlier chapters on Morphology and Life-history though these organisms are dealt with in the second half of the book. At the end of each chapter the author has given certain references for specific information and in this, of course, as the author states, the choice may not necessarily please every worker.

The book is well illustrated. In authenticating the figures in many places the author departs from the normal practice and gives the names of authors of Text-books rather than the original authors of those figures.

The author includes Chlorophyceæ, Charophyceæ, Phæophyceæ and Rhodophyceæ under the phylum Euphycophyta as he considers that these are distantly related. He derives the Rhodophyceæ and Phæophyceæ from simple filamentous and branched heterotrichous green algal types respectively. Phylogeny among algæ has generally been based on pigmentation, comparative morphology, and ontogenic features. The only feature of commonness between these groups is the presence of Chlorophyll *a*; so do the Chrysophycophyta and the Myxophycophyta, which are separated by the author from the Euphycophyta. Many workers have in the past separated the blue-greens and placed it closer to the bacteria based especially on cell-structure.

Nomenclaturally Florideæ and Protoflorideæ should be Florideophycideæ and Bangiophycideæ. Botryococcaceæ (Wille, 1909) has priority over Heterocapsaceæ (Pascher, 1912). Prof. Chapman, in the sense in which he has defined the family, still includes *Botryococcus* among the Xanthophyceæ. *Botryococcus* has been shown to be a green alga by the presence of starch (Blackburn, 1936) and Chlorophylls *a* and *b* (Belchior and Fogg, 1955) and it would, therefore, be appropriately included in the Chlorophyceæ under the Chlorococcales.

In the chapter on Reproduction and Evolution, Prof. Chapman has expanded at length his ideas on the evolution of the present-day green, brown, and red algæ. He gives elaborate and intricate charts giving expression to some of his ideas

on Evolution of the algæ. The existence of parallelism in evolution of the major groups of algæ has been recognized for a long time. Similarity in life-cycles and a study of phylogeny has led Prof. Chapman to the hypothesis that the Chlorophyceæ, Phæophyceæ and Rhodophyceæ may be interrelated and hence he includes them in Euphycophyta. It would be out of place here to go into these interesting theories.

Prof. Chapman has intensively studied for the past many years the Ecology of the Rocky Coasts and of the Salt marshes. Chapters in this book dealing with these aspects are very welcome.

Prof. Chapman has had considerable experience in teaching Algæ at the Auckland University and as such his book would be most welcome for the undergraduate student coming as it does from an experienced teacher. He has endeavoured to provide in this book material that may enable the student to see more of the algæ than is needed by the syllabi and thus the book is bound to create an interest for a further study of these interesting group of organisms.

T. V. DESIKACHARY.

College Botany, Vol. I. By H. C. Gangulee, K. S. Dar and C. Datta. (The Central Book Agency, Calcutta-12), 1961. Pp. 1087. Price Rs. 27-50.

This text-book written on conventional lines is geared to meet the needs of students of the degree courses in Indian Universities. The authors, who are teachers, have experience of the needs and difficulties of the students. The descriptions, based as they are, on Indian plants ought to appeal to the teachers and students alike. The publication of a second revised edition within a period of two years reveals its popularity. The volume is profusely illustrated and its price is moderate.

M. K. S.

The Wealth of India. *Raw Materials*, Vol. VI. Pp. xxxii + xiv + 483. Price Rs. 40-00; (Supplement) *Fish and Fisheries*, Vol. IV. Pp. iii + xv + 132. Price (not given).

The Sixth volume, the biggest so far issued, of this monumental publication—*The Dictionary of Indian Raw Materials and Industrial Products*—maintains the same excellent standard as the previous volumes both in the nature of its contents and in its get-up. There are 388 entries—367 on plant species, 11 on animals and animal products, and 10 on minerals. There

are 14 plates (seven of which are coloured) and 185 text-figures.

A close study of some of the articles shows that great care has been taken to make the information both authoritative and accurate. The compilers have indicated that in the preparation of this volume nearly 400 books and about an equal number of original papers have been consulted. Besides, a number of specialists have also helped in clearing doubts wherever such existed in the published records, and making the entries authentic.

The items under minerals include lignite, limestone, manganese and mica. There is also some interesting information on mineral springs. Lac insects and locusts figure prominently besides lions and leopards and monkeys in the entries under animals. The bulk of the book is on plants of economic and medicinal values, and some of the chief items are lichens, linum (linseed), Madhuca (Mohwa), Malus (apple); Mangifera (mango), and Musa (plantain).

This series which forms a veritable source of information should be in the possession of not only all scientific libraries but also in every public library so that interested readers may have easy access to them.

*Fish and Fisheries.*—This is a Supplement to Vol. IV, of *Raw Materials*, which was published in 1957. It is paper-bound and contains 132 pages besides an index of XV pages giving the names of the fishes and fish products dealt with in the text. The first 55 pages deal concisely with fishes giving their names and habitat. Then in another third part of the book are explained the marine and inland fisheries, fishing craft and gear. The remaining pages deal with preservation, processing, marketing and trade.

#### Books Received

From: (Academic Press, Inc. Pub., 111 Fifth Avenue, N.Y. 3):

*Mathematics in Science and Engineering* (Vol. V)—*Optimization Techniques with Applications to Aerospace Systems.* Edited by G. Leitmann, 1962. Pp. xiii + 453. Price \$ 16.00.

*The Bacteria—A Treatise on Structure and Function* (Vol. III)—*Biosynthesis.* Edited by I. C. Gunsalus and R. Y. Stanier, 1962. Pp. xv + 718. Price \$ 19.50.

*Italian Physical Society Topics of Modern Physics* (Vol. I)—*Geometrodynamics.* By J. A. Wheeler, 1962. Pp. xxiii + 334. Price \$ 6.50.

*Trace Elements in Human and Animal Nutrition* (2nd Edn.). By E. J. Underwood, 1962. Pp. vii + 429. Price \$ 9.50.

*Advances in Nuclear Science and Technology.* By E. J. Henley and H. Kouts, 1962. Pp. xi + 355. Price \$ 12.00.

*Differential Geometry and Symmetric Spaces.* By S. Helgason, 1962. Pp. xiv + 486. Price \$ 12.50.

From: (Addison-Wesley Pub. Co., Reading, Massachusetts, U.S.A.):

*Study Guide for Basic Concepts of Physics.* By Beiser-Beiser, 1962, Pp. viii + 120. Price \$ 2.25.

*Basic Concepts of Physics.* By A. Beiser, 1962. Pp. x + 341. Price \$ 7.75.

*An Introduction to Mathematical Machine Theory.* By S. Ginsburg, 1962. Pp. ix + 148. Price \$ 8.75.

*Collection of Problems in Physical Chemistry.* By J. Bares, C. Cerny, V. Fried and J. Pick, 1962. Pp. xvii + 603. Price \$ 9.75.

*An Introduction to the Chemistry of Complex Compounds.* By A. A. Grinberg, 1962. Pp. xxi + 363. Price \$ 15.00.

*Ordinary Differential Equations.* By L. S. Pontryagin, 1962. Pp. vi + 298. Price \$ 7.50.

From: (Cambridge University Press, London, N.W. 1):

*The Nature of Biochemistry.* By E. Baldwin, 1962. Pp. xiii + 110. Price 13 sh. 6 d.

*Clouds, Rain and Rain Making.* By B. J. Mason, 1962. Pp. 145. Price 22 sh. 6 d.

*The Theory of Electromagnetic Flow Measurement.* By J. A. Shercliff, 1962. Pp. xi + 146. Price 27 sh. 6 d.

*Discovery Reports* (Vol. XXXII)—*The Natural History and Geography of the Antarctic Krill* (*Euphausia superba* Dana). By J. W. S. Marr, 1962. Pp. 33-464. Price 200 sh.

*Discovery Reports* (Vol. XXXIII)—*Rhizocephala.* By H. Boschma, 1962. Pp. 55-94. Price 22 sh. 6 d.

REGISTER FOR BLOOD DONATION

## SCIENCE NOTES AND NEWS

### Award of Research Degree

The Andhra University has awarded the D.Sc. degree in Physics to Shri M. G. Seshagiri Rao for his thesis entitled "Ultrasonic Studies in Liquids and Solutions"; D.Sc. degree in Physics to Shri V. Muralidhara Rao, for his thesis entitled "Development of the 8 mm. Technique and Measurements on the Dielectric Dispersion of Certain Liquids"; and Ph.D. degree in Physics to Shri C. V. V. S. N. K. Santharam for his thesis entitled "Electronic Spectra and Electronic Structures of the Monoxides of Arsenic and Phosphorus".

The Osmania University has awarded the Ph.D. degree in Chemistry to Shri Saktharam Pathak, for his thesis entitled "Studies on Sugarcane Bagasse"; and Ph.D. degree in Mathematics to Shri Teeka Rao for his thesis entitled "Superposability and other problems in Magnetohydrodynamics".

### Lady Tata Memorial Trust Scholarships for 1963-64

The Trustees of the Lady Tata Memorial Trust are offering six scholarships of Rs. 250 each per month for the year 1963-64 commencing from 1st July 1963. Applicants must be of Indian nationality and *Graduates in Medicine or Science* of a recognised University.

Application forms and other particulars may be had from the Secretary, the Lady Tata Memorial Trust, Bombay House, Bruce Street, Fort, Bombay-1.

### Prizes for Scientific Articles

The A. M. N. Ghosh Memorial Committee has announced a cash prize of Rs. 100 for the year 1963, for the best paper on any aspect of "Exploration and Production of Petroleum Resources in India". Further particulars can be had from Dr. V. Raghavendra Rao, Secretary, A. M. N. Ghosh Memorial Committee, Oil and Natural Gas Commission, Tel Bhawan, Dehra Dun.

The Indian Science News Association has announced cash prizes of the value of Rs. 250 each (Meghnad Saha Popular Science Prizes for 1962-63) to the authors of articles adjudged to be the best in each of the following subjects: (a) Plasma Physics; (b) Biological Control of Insects; (c) Future of Petrochemicals in India; (d) The Growth of Paleontological Studies in

India; (e) How far has caste been affected by Urbanization or Industrialization.

For particulars please contact the Honorary Secretary, Indian Science News Association, 92, Acharya Prafullachandra Road, Calcutta-9.

### Raptakos Medical Research Board Fellowships for 1963

The Raptakos Medical Research Board Fellowships for the year 1963 have been awarded to the following candidates: Mr. Ram Prakash Agarwal, K. G. Medical College, Lucknow University, Lucknow; (Miss) Vijayalaxmi Ramachandra Menon, J. J. Group of Hospitals, Bombay; (Miss) Lalita S. Parker, Indian Cancer Research Centre, Parel, Bombay-12; Dr. Jagjit Singh Pasricha, All-India Institute of Medical Sciences, New Delhi; Mr. V. V. Bhat, National Chemical Laboratory, Poona-8; Mr. P. D. Desai, Ramnarain Ruia College, Matunga, Bombay-19.

### The Institute of Physics and the Physical Society Conferences on "High Magnetic Fields" and "The Liquid State"

The Institute of Physics and the Physical Society announces the following Conferences:

I. Conference on "High magnetic fields, their production and their applications" to be held in the University of Oxford on the 10th, 11th and 12th July 1963.

Contributions on the following topics are invited: (1) The generation of high magnetic fields: (a) by means of normal conducting materials, (b) by means of superconductors. (2) Properties of solids in high magnetic fields, to include optical, magnetic and transport properties.

Correspondence regarding the program should be addressed to Dr. N. Kurti, Clarendon Laboratory, Parks Road, Oxford.

II. Conference on the "Liquid State" to be held at Imperial College, London, from 9 to 13 September, 1963.

The emphasis will be mainly on the fundamental properties of liquids and simple solutions. The Conference will be divided into four main sections each introduced by an invited review paper: Structure and excitation spectra; Equilibrium properties, evaporation and solidification; Transport and dissipative processes; Fluctuation; Electronic properties.

Offers of papers should be sent, with three copies of abstracts (100–200 words), to Dr. H. N. V. Temperley, Building E. 1, Atomic Weapons Research Establishment, Aldermaston, Berkshire, before 31st March, 1963.

#### International Union of Testing and Research Laboratories for Materials and Structures (RILEM)

*Seminar by Correspondence* is a new method promoted by RILEM of studying problems of common interest by specialists of various countries without their having to undertake the actual travelling which is both time and money-consuming. The first theme chosen for this was "Methods and Apparatus for the Measurement of Humidity in Building Materials".

The proceedings of this first seminar by correspondence have been published in the *RILEM Bulletin* (Nr. 15, June 1962) and contain the papers submitted and the discussions that arose among the participants. This publication represents a first-order document on a question which will be of interest for a great number of institutes and laboratories.

#### WHO Publications

In order to make their publications more widely known and to ensure that they are available at comparatively low prices payable in local currency, the World Health Organisation Regional Office for South-East Asia has established the following special rates at which all WHO publications may be available to all medical and health workers in this region—in both their private and their official capacity:

1. Single copies of all WHO publications—not out of print—at 50% discount on the list price (payable in local currency).
2. (a) Subscriptions to three important WHO publications—*WHO Technical Report Series*, *WHO Bulletin* and *WHO Chronicle* at Rs. 70 per annum or equivalent amount in local currency.
- (b) Subscriptions to all important WHO publications at Rs. 240 per annum or equivalent amount in local currency.

As of 1 January 1963, the WHO Regional Office for South-East Asia (Address: The Regional Director, World Health Organisation, World Health House, Inderprastha Estate, New Delhi. Attention: Reports Officer) will act as the principal agents for WHO publications in India and other countries of the South-East Asia Region.

#### International Year of the Quiet Sun

The year 1964–65, which will be a year of sunspot minimum, will be observed as the International Year of the Quiet Sun (IQSY). At a meeting of the International Geophysics Committee (CIG) held in Paris in March 1962, the programme of the IQSY was formulated. 36 countries have indicated their intention to participate in the IQSY programme. The IQSY will be concerned with problems of the upper atmosphere, the interplanetary medium, solar-terrestrial relations and solar physics. The fields of investigation include ionospheric physics, aurora and air-glow, geomagnetism, cosmic rays, aeronomy, meteorology and solar activity.

The U.S. Programme for the IQSY is published in the *IGY Bulletin*, No. 60 of the National Academy of Sciences.

#### Thermoelectricity in Irradiated Glass

It is well known that in dielectrics, like glass, charge displacements occur when there is an external applied electric field. Also it has been recently reported that if glass specimens heated to different temperatures are exposed to  $\gamma$ -rays or X-rays, thermally released charge displacements occur even in the absence of an externally applied electric field.

The same effect has now been observed when some types of glasses are irradiated at room temperature with Cobalt-60 radiation, and subsequently heated to temperature gradients 20–40° C./mm.

In the experiment a cobalt-type glass plate (calcium-aluminium-borate of molar composition 1.0 CaO, 4.5 B<sub>2</sub>O<sub>3</sub>, 1.0 Al<sub>2</sub>O<sub>3</sub>) 3 cm.<sup>2</sup> × 0.32 cm. thick is sandwiched between parallel plate electrodes; the heating is effected by conduction through one of the electrodes, while the displacement current of the irradiated sample is measured by an electrometer connected to the other electrode.—(*Phys. Rev. Letter*, 1962, 9, 339.)

#### Miniaturization for Plant Life

A new compound trademarked "Cycocel", introduced by American Cyanamid Company, is claimed to reduce the size of ornamental plants by one-third to one-half without materially affecting size or time of bloom.

The chemical is being used on red poinsettias. Poinsettias are an extremely difficult plant to cultivate. One of the major problems has been the plants' tendency to grow excessively large. Red poinsettias properly treated with Cycocel not only make a shorter, sturdier plant but

have a greater resistance to wilting. Foliage of treated plant is greener and the red tracts are a deeper, richer colour.

Cycocel has been tested successfully on other ornamentals too, e.g., azaleas, lilies, chrysanthemums, camellias and carnations. The growth retardation on these plants has proven similar to that noted on poinsettias.—(*J. Frank. Inst.*, 1962, 274, 330.)

#### Production of Mendelevium

The Joint Nuclear Research Institute in Dubna, Moscow, announces the successful production in appreciable quantity of the element Mendelevium with the help of the Institute's Cyclotron, by irradiating uranium with high intensity neon ions. Mendelevium, the transuranium element of atomic number 101, was discovered seven years ago but was up till now produced artificially only in infinitesimal quantities.

#### A New Process for Making Artificial Diamonds

The General Electric Company, U.S.A., has announced a new process for making diamonds directly from graphite without the use of a catalyst.

In order to convert graphite into diamond it is necessary to alter the arrangement of the carbon atoms within the crystal structure of the molecule. The comparatively loose arrangement in graphite has to be compacted to give the much tighter diamond crystal structure.

The current process of converting graphite into diamond necessarily involves two requirements: (1) the use of a metal catalyst to facilitate the transition from one crystal structure to the other and (2) an ultra-high temperature-pressure combination which has to be maintained over a period of time.

The new process, announced by G.E.C., uses only a super high pressure-temperature combination and dispenses with the metal catalyst. In the new device pressures of 3 million p.s.i. at temperatures above 5000° C. can be maintained. These are three times as high as those used in the catalytic process.

Heat is applied by discharging an electric capacitor through the graphite after it has been brought to a high pressure; the transformation from graphite takes place in a few thousandths of a second. The rise in temperature and pressure can be controlled and the products readily recovered. The diamonds produced are very small; many of the crystals are transparent.

The new method is an important step forward in understanding the atomic forces at work within the crystalline materials.

This process has also made it possible for the first time to establish experimentally the "triple" point for carbon on the pressure-temperature scale. This has been located at 1,800,000 p.s.i. and 3800° C. where carbon exists simultaneously as diamond, graphite and liquid.—(*Research*, 1962, 15, 490.)

#### Geomagnetic Disturbances at South Indian Stations Produced by the July 9 Nuclear Explosion

Disturbances in the earth's magnetic elements at Indian stations produced by the high altitude nuclear explosion off Johnston Island on July 9, 1962 have been reported by Dr. P. R. Pisharoty of the Indian Meteorological Department, Colaba Observatory, Bombay.

The geomagnetic observatories at Annamalai-nagar (geographically 11° 24' N, 79° 41' E; geomagnetically 1·8° N, 149·4° E), and Trivandrum (geog. 8° 29' N, 76° 57' E; geom. 0·9° S; 146·3° E) recorded marked changes in the Earth's field around 09 h. U.T. on July 9, 1962. The changes at the two stations were similar in type and somewhat resembled a magnetic storm on a much smaller scale. The disturbance in H at both stations consisted of a positive sudden commencement, an extremely short initial phase, and a main phase in which the H value was depressed below normal by about 35 γ. The total duration was about 12 minutes. The disturbances shown by the magnetograms at Alibag (geom. 9·5° N, 143·6° E) were very much less.

It may be noted that the *Argus* experiments as well as the Johnston Island explosions of August 1958 did not produce any observable geomagnetic effects at Trivandrum or Annamalai-nagar or Alibag.

Evidently the effects now observed at the South Indian stations were due to the high megaton range of the nuclear charge. These effects are attributable to positively charged particles drifting westwards (from 169° E.) and arriving over South India (80° E.) after traversing only a quarter of the global circuit.—(*Nature*, 1962, 196, 822.)

#### Microstructures in Carbonaceous Meteorites

Recent investigations on the microstructures which are present in carbonaceous meteorites have led to controversial interpretations claiming them as of organic origin. In an article contributed to (*Nature*, 1962, 196, 929) Prof. G. Mueller of London University, has reported the results of his observations under the polarizing microscope of twenty carbonaceous meteoritic stones.

From the point of view of types and abundance of microstructures present, the meteorites could be divided into three broad classes: (1) The first group characterized by the presence of troilite plates and abundant glass globules. This group includes the Orgueil meteorite. (2) The second group in which there are no troilite plates, and the glass globules are less abundant, whereas freely grown, cored olivines are the most common. This group contains the Mighei meteorite. (3) The third group contains no troilite plates and practically no glossy structures, and the cored olivines are the coated or sintered type.

The extensive range of stones examined and the consistence and graded character of the mineral grains observed in them would seem to remove the necessity to postulate an organic origin for any of them. Prof. Mueller concludes that the majority of the structures claimed as of organic origin could be readily and quite unequivocally identified as mineral grains.—(*Nature*, 1962, 196, 929.)

#### Fossil Particle Tracks in Natural Micas

Electron microscope studies have shown that fission fragments from uranium-235 produce tracks in mica and other minerals. In these experiments the fission fragments are produced by irradiating a uranium source with thermal neutrons from a nuclear reactor. Price and Walker report observations of such tracks in samples of natural micas which had not been deliberately irradiated. The tracks in these minerals were produced over a long period of time by natural radiation processes and constitute, therefore, a 'fossil' record of the radiation exposure of the minerals.

Many natural micas contain small inclusions of other minerals which are surrounded by pleochroic haloes. It has long been known that these haloes arise from radiation damage by  $\alpha$ -particles produced from uranium or thorium impurities in the inclusion. Since uranium undergoes spontaneous fission, the region in the immediate vicinity of such an inclusion should show fission fragment tracks, provided such tracks are stable over long periods of time.

Price and Walker made observations on such tracks seen in a crystal of biotite adjacent to a

halo-producing inclusion. The biotite flake was etched in hydrofluoric acid prior to observation in order to 'develop' and 'fix' the fission fragment tracks by a selective etching process.

From the measured track density in samples of natural mica, Price and Walker infer a track storage time of at least  $10^6$  years. This new technique shows potential applicability for measuring low concentrations of uranium impurities and also in problems of geochronology.—(*Nature*, 1962, 196, 732.)

#### Venus's Magnetic Field

According to data transmitted by Mariner II there is no evidence of a Venusian magnetic field that could be detected at any point in the Mariner trajectory.

Mariner II, the Venus probe, was launched on August 27, 1962 and passed closest (21594 miles to Venus on December 14, 1962 (see *Curr. Sci.*, December 1962, p. 530). The magnetometer which Mariner carried showed no rise in the average value of the magnetic field above the interplanetary value. It has been observed that fluctuations, if anything, were even smaller in the vicinity of Venus than in neighbouring parts of interplanetary space. However, this does not conclusively prove that Venus has no magnetic field.

The possibility of the existence of a magnetic field close to Venus, at distances less than five times Venus radius (3,800 miles), cannot be ruled out. Solar winds—charged particles sent off the surface of the Sun at great velocities—could press an extremely weak magnetic field close in to the planet and thus out of the detection of the Mariner magnetometer.

The Mariner finding is consistent with the theory that planets rotating less rapidly than Earth have no or extremely small magnetic fields. It also supports the view that Venus has no Van Allen type of radiation belt surrounding it.

#### Erratum

In the article on "Application of Chemical Analysis to Some Cases of Synonymity in Botanical Nomenclature," *Current Science*, December 1962, on page 496 the letter 'S' which appears in the Structure Formula Fig. I should be 'O'.



# THE INDIAN OCEAN EXPEDITION\*

N. K. PANIKKAR

*Director, Indian Programme, International Indian Ocean Expedition*

THE Indian Ocean Expedition which is a multinational project for the systematic exploration of one of the least known oceanic regions of the world started in 1962 and during the coming three years nearly forty ships belonging to some twenty countries are expected to join this large-scale effort in oceanology. First discussed and organised by the Special Committee on Oceanic Research of the International Council of Scientific Unions, the project found support from the national academies and scientific institutions of many countries. With further planning and organisation the project has grown considerably during the last three years and is being co-sponsored by the UNESCO and the recently formed Intergovernmental Oceanographic Commission. The concept of co-ordinated efforts to study global scientific problems was one of the contributions of the International Geophysical year but the Indian Ocean Project is the first attempt in the realm of oceanography to bring together many countries and scientists of various disciplines all over the world under one project, with a common basic programme, which has been developed by some of the world's leading oceanographers participating in the various working groups of the SCOR. At a time when much is heard of space research, interest in the oceans which occupy about 70% of the earth's surface is also a welcome sign that the "inner space" as something near to man is worthy of much closer study than has been attempted in the past. The study of the Indian Ocean on whose fringes live nearly 25% of the world's population in a very low stage of economic development, may help to locate and utilise resources in food and minerals and at the same time give a more precise idea of the natural phenomena like the monsoons which have such close impact on the economy and well-being of bordering countries. These considerations apart, studying an oceanic region to fill in the many gaps in our knowledge is itself a sufficiently strong incentive for undertaking such a venture. The theory of the monsoon, formation of tropical cyclones, presence or otherwise of the equatorial counter current, the nature of the Indian Ocean floor as compared

with the Pacific, sea circulation in an ocean which is half land-locked: these are all questions of absorbing interest whose answers oceanographers all over the world are eager to seek.

India has special interest in this Expedition because of her geographical location. Many problems in the field of marine sciences in which we are interested are amongst the basic scientific investigations which will be taken up by the participating teams. The Government of India set up the Indian National Committee on Oceanic Research in 1960 under the Chairmanship of Dr. D. N. Wadia. Through this Committee and its various Working Groups Indian scientists and Institutes connected with oceanography have been brought together in a common forum and a national programme has been drawn up which, although a modest one, takes note of all important fields of modern oceanology.

## SHIPS AND PERSONNEL

Four ships have been earmarked for the Expedition from India. These are—INS KISTNA, a 300 ft. frigate of the Indian Navy, specially refitted for oceanographic work; a 92 ft. Fisheries Research Vessel R.V. VARUNA of the Indo-Norwegian Project, built in Norway specifically for fisheries oceanographic work in India; a 50 ft. vessel R.V. CONCH belonging to the Kerala University equipped for coastal oceanographical observations; and a 57 ft. purse-seine fishing vessel M.F.V. BANGADA of the Deep Sea Fishing Station of the Union Ministry of Food and Agriculture. The main observations will be from INS KISTNA and R. V. VARUNA. KISTNA can accommodate about 20 scientists while R.V. VARUNA can take 5 scientists. Both these vessels have been provided with all essential oceanographic equipment. The absence of a heavy-duty winch on KISTNA excludes geophysical observations for the time being but it is hoped to have this installed before long. The personnel for participating in the Indian Programme are drawn from Indian Scientific Institutions of the Ministry of Defence (Defence Science Organisation and Hydrographic Department of Navy); Ministry of Transport and Communications (India Meteorological Department); Ministry of Food and Agriculture

\* Lecture delivered at the 28th Annual Meeting of the Indian Academy of Sciences, Bombay, December 1962.

(Central Marine Fisheries Research Institute, Mandapam, and the Deep Sea Fishing Station, Bombay); Ministry of Scientific Research and Cultural Affairs (C.S.I.R., The Survey of India, the Botanical and the Zoological Surveys of India); Ministry of Mines and Fuel (Geological Survey of India) and the Department of Atomic Energy. Some of the State Fisheries Departments are also joining the programmes. Apart from the Government Departments, the Universities of Kerala and Andhra, and the Tata Institute of Fundamental Research at Bombay are also active participants. The responsibility for co-ordination and direction of the Indian

main areas of observation will be the Arabian Sea and the Bay of Bengal with the equatorial region as the rough southern limit. A large number of stations will be occupied in these regions, some of them will be deep water stations up to 3,000 meters and the remainder shallow stations up to 500 meters. Cruising plans have been so worked out that intervals between the stations will not exceed sixty miles. The hydrographic data from these stations will be used for circulation studies and for dynamical computations of ocean currents. Direct observations of ocean currents are not being made at present but this programme will be develop-

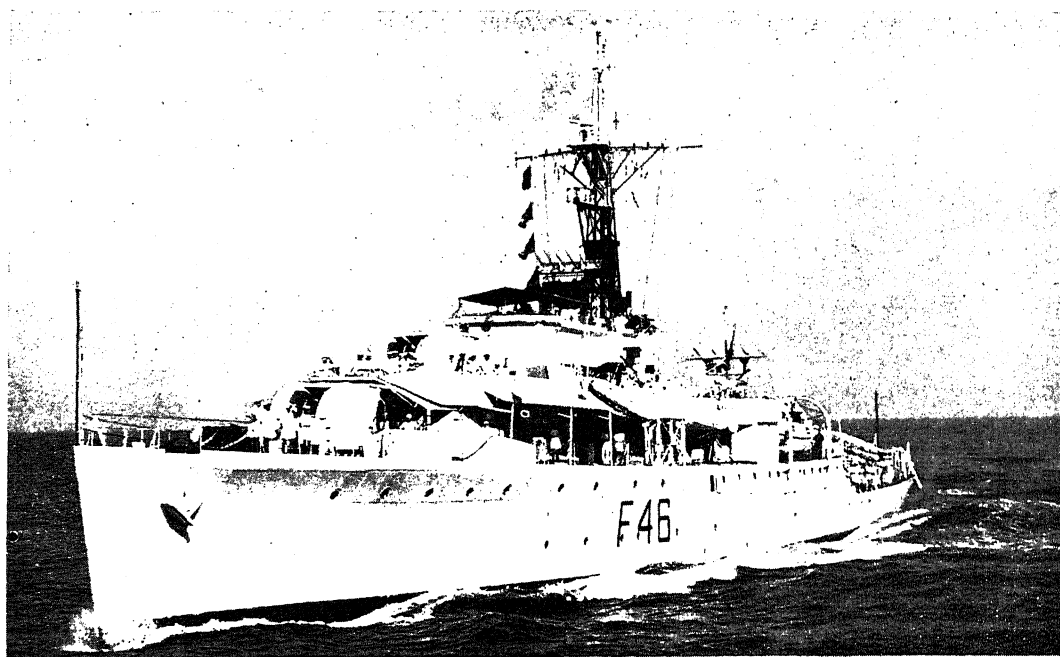


FIG. 1. 'INS Kistna'—Indian Navy's frigate fitted for oceanographic work. Principal ship in Indian participation.

Programme of the Expedition has been entrusted to the Council of Scientific and Industrial Research under whose aegis the National Committee on Oceanic Research functions as the policy-making body to advise the Government of India in the field of oceanology.

#### PROGRAMMES

The Indian Programme will include almost all branches of research in modern oceanography. The physical properties of the water masses and the process of vertical and horizontal circulation will be studied and all relevant data collected for this purpose. The

ed within the course of this year. Wave and tidal observations from existing and new tidal observatories are being developed.

In the field of chemical oceanography observations cover salinity, phosphates, nitrates, silicates, oxygen and total phosphorus. Full coverage has not been secured in the earlier cruises. Primary production studies will be carried out by  $C^{14}$  Technique. The Atomic Energy Department at Trombay is paying special attention to radiometry. The geochemical behaviour of certain elements is being taken up for special investigations at the Tata Institute of Fundamental Research.

The importance of locating new fisheries resources being one of the major objectives of the Expedition, the Marine Biology and Fisheries Programme is oriented to understand the productivity of the seas, the location of spawning grounds of commercial fishes and the location of areas capable of intensive fishing. Critical studies of plankton production and distribution of the major components of marine plankton will be taken up from selected areas. Plankton sampling for the Expedition as a whole

being developed by the C.S.I.R., with technical assistance from the UNESCO.

The Marine Geology and Geophysics Programme includes magnetic, seismic and gravity studies but the Indian Programme is likely to be slow in implementation owing to inadequate instrumentation. Regular Echo-Sounding with the precision depth recorder will, however, be made for getting profiles of the ocean bottom all along the routes taken by the ships, so that the data collected could be used to develop accurate bathymetric charts.



FIG. 2. 'R. V. Varana'—Indo Norwegian Project Fishery Research Vessel. Second participating ship in the Indian Programme.

is being made through the Indian Ocean Standard net which has been developed by the SCOR working group in biology as a basis for the comparison of results obtained in different areas by different ships. The large volumes of plankton material collected by this standard method by all the ships are proposed to be brought to the Indian Ocean Biological Centre established in Ernakulam near Cochin, from where this material will be sorted and placed in the hands of world specialists for further studies, the bio-mass estimations being made at the Biological Centre itself. This centre is

By far the most ambitious programme from the Indian side is in the field of Meteorology. The studies will include the sequence of events and the spatial relations between those events which make up the large-scale monsoon circulation in the Indian Ocean, which although known from ancient days to the mariners is still a very imperfectly understood atmospheric phenomenon. The complete reversal of ocean currents and air circulation when the South-West Monsoon changes to the North-East is a factor which has far-reaching consequences in the oceanic phenomena and the heat budget of this part of

the earth. The South-West Monsoon, whose onset is a remarkable example of the effect of differential heating of land and water; probably originates in areas south of the equator and evidence is gradually accumulating to show that what is now considered as one monsoon may be the combination of several monsoons having different sequences in geographically separated areas. To study all these phenomena in a systematic manner and to take advantage

of weather phenomena in the Indian Ocean would have been subjected to the closest study. Not since the Valdivian Expedition of 1898-99 has any such attempt been made to study Indian Ocean Meteorology. The India Meteorological Department has done much preparatory work towards the understanding of these complex forces and recently as part of the expedition effort, systematic radiosonde observations have been initiated for oceanic regions from

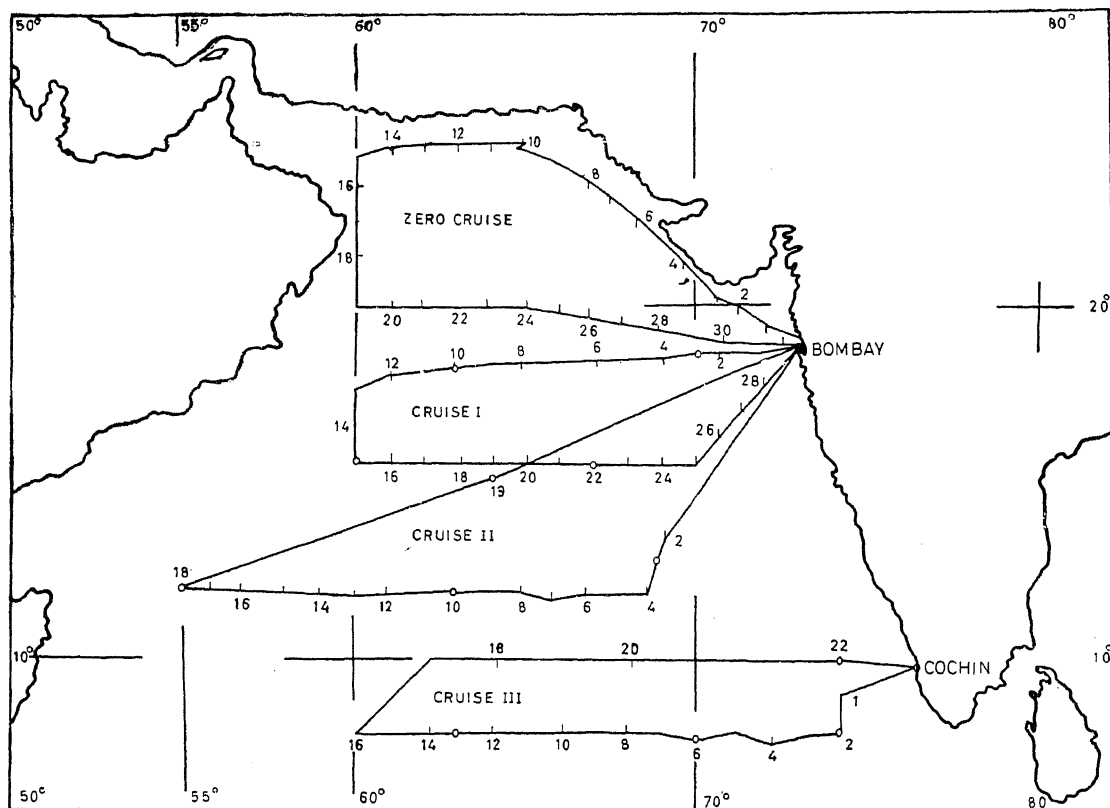


FIG. 3. Track chart of 'INS Kistna' and the station positions where oceanographic observations have been carried out during 1962.

of the large volume of atmospheric and oceanographic data that would be accumulated as a result of the Expedition, an International Meteorological Centre is being established in Bombay by the Government of India with the assistance of the U.N. Special Fund. Advanced computer techniques will be employed for quantitative treatment of the data. The U.S. Weather Bureau is collaborating with this Centre in a bilateral programme of weather studies aided by special aircraft. It is hoped that by the time the Expedition is over the whole range

INS KISTNA in the Arabian Sea. During the Expedition period it is also proposed to establish first class ocean weather observatories at Minicoy, Amindivi and Port Okha.

The problem of oceanic circulation of the Arabian Sea is a matter of special importance to India. The fact that over two-thirds of the total annual production of about a million tons of sea fish in the country is obtained from the west coast obviously points to a higher productivity of the Arabian Sea Waters as compared with that of the Bay of Bengal. But the

exact reasons for this increased productivity in terms of oceanographic conditions still remain to be elucidated. Many former observers have conjectured the possibility of nutrient laden deep waters coming to the surface through the influence of (a) bottom drifts striking against sub-marine ridges; (b) upwelling of water associated with the prevailing current systems; (c) large-scale turbulence caused by strong monsoon winds which pile the water against the west coast of India; and (d) coastal eddies resulting from the local wind effects.

Recent studies made by researchers of the Central Marine Fisheries Institute and of the Indo-Norwegian Project have clearly shown that deep water of low temperature and low oxygen content occur considerably higher up near the surface on the west coast of India. Indications of low temperature water in coastal regions are also available from surface temperature and salinity charts for the Arabian Sea published by the Dutch Meteorological Institute. A number of observations showing high values of phosphates for the Arabian Sea coastal waters of the west coast have been reported as against the Bay of Bengal coastal waters. Intensive studies on the standing crop of plankton have also shown substantially high organic production off the Malabar coast. The correct understanding of the forces responsible for this upwelling and indeed whether it is upwelling in the classical sense or a combined effect of several factors will be one of the problems whose solution will be sought by Indian workers because of the very close relation which these phenomena have on the movements and shoaling of the sardines and the mackerel which form the backbone of Indian Marine Fisheries. Valuable data in this direction have already been obtained by the work of R. V. VARUNA. Oceanography team work-

ing at the Andhra University has shown upwelling in the Waltair Coast but its relation to fisheries of the Bay of Bengal remains to be investigated. Indian ships and the U.S. Research Vessel ANTON BRUUN will be devoting some time to this problem.

Oceanography is a very young science in India. Pioneer work was accomplished by the "INVESTIGATOR" during the beginning of this century and in the series of later investigations on surface temperature and salinities by Col. Seymour Sewell who led the John Murray Expedition to the Arabian Sea in 1933-34. Some of the earliest observations on the optical properties of sea-water were made by Sir C. V. Raman during 1920. In recent years the notable advances have been the growth of two schools of oceanography since 1950, one associated with the Central Marine Fisheries Institute at Mandapam and its Substations and the other associated with the Andhra University under the leadership of the late Prof. Mahadevan and Prof. E. C. LaFond. The Naval Physical Laboratory at Cochin has come to the fore recently in certain aspects of physical oceanography and many other institutions are newly entering this field. Inadequacy of research vessels for work which cramped earlier efforts has now been overcome. It is hoped that Indian participation in this expedition will result in substantial advancement to oceanological studies in the country and the development of applied marine sciences based on a solid foundation of fundamental work. A country with over three thousand miles coastline and a pre-eminent geographical situation in the Indian Ocean will require a number of trained oceanographers and a vigorous marine sciences programme towards which Indian participation in this Expedition can only be just a beginning.

## PROBLEMS OF OPERATING RESEARCH SHIPS\*

C. S. RAMAGE

**T**HIRTY or forty years ago, when few oceanographic cruises were undertaken, planning, execution, research and publication were expertly and exhaustively carried out by first-class scientists. Today, although the number of research ships has greatly increased, the number

of interested scientists has not increased proportionately. Consequently the data from many voyages have not been analysed nor disseminated, wasteful duplication occurs and oceanographers are so busy planning and participating in new voyages that they have little time to conduct research on the results. No oceanographic cruise should be undertaken unless competent scientists make themselves available for all aspects of data collection and processing, research and publication. Since the supply of

\* Abstract of contribution to symposium on "Oceanographic Research and Related Topics" presented at the 28th Annual Meeting of the Indian Academy of Sciences, Bombay, December 1962.

oceanographers is limited, international collaboration should be invited for each voyage.

The recent tendency to build ever larger oceanographic vessels has some merit, particularly since these ships with their long cruising ranges can explore remote ocean areas. However, the cost of operating a large ship is high. Regions such as the South Indian or East Pacific Oceans might be more suitably explored by an adaptation of the naval task force or whaling fleet concepts. A scientific "mother ship",

ideally a light aircraft carrier, would act as a mid-ocean base, providing refuelling, repair, hospital, recreation and scientific processing services to a group of small, relatively short range oceanographic vessels. Not only would the observations cost less than comparable observations made by large oceanographic vessels, but entirely new and valuable oceanic and atmospheric measurements could be made from the aircraft carrier.

## OCEAN-WAVES\*

P. R. PISHAROTY

**O**CEAN-WAVES generated by wind form the most conspicuous interaction between the atmosphere and the ocean. The formation of breakers, foam and spray may perhaps change the quantities like evaporation and heat exchange by an order of magnitude and also provide the giant nuclei for the initiation of precipitation. Knowledge about wind generated ocean-waves can be broadly classified as under :—

- (i) The precise physical processes responsible for the transference of energy from the wind to the water waves ;
- (ii) A correct description of the waves so generated ;
- (iii) Forecasting of the ocean-waves from the antecedent wind conditions.

**Wave Generation.**—According to Jeffreys (1925) a *uniform* wind passing over a set of already existing waves induces a deficit of pressure on the leeward side of the crests and an excess on the windward. The component of this variable pressure distribution in-phase with the wave-slope supplies energy for the wave development. The consequences of this theory are not fully borne out by the empirical facts of observations.

According to Phillips (1957, 1958) a random variation of normal pressure associated with the onset of a *turbulent* wind produces waves which then develop most rapidly through a resonance mechanism occurring when a component of the surface pressure distribution moves at the same speed as the free surface wave with the same wave number.

Miles (1957) has developed a theory based on a *laminar flow* of the wind with a *logarithmic shear* and is an improvement on the Kelvin-

Helmholtz theory of instability of an interface with a density-discontinuity and a velocity-discontinuity.

Apparently, there is a transition frequency (Phillips, 1961), depending on the fetch and duration; below which waves develop according to the resonance-mechanism of Phillips and above which according to the shear-instability-mechanism of Miles. Much work remains to be done in the theoretical as well as in the experimental field. We do not know the exact wind distribution in the first ten metres above the surface of a large water body, let alone the ocean. Are there eddies? Is the flow laminar? What are the variations of wind with height when the surface is unruffled and when it is violently agitated? These are questions for which we do not have definite answers. Let us hope that the Indian Ocean Expedition will provide some of the answers.

**Description of an Ocean Surface Agitated by Wind.**—The best description of an ocean surface under the action of a strong wind acting over a sufficiently long fetch for a sufficiently long time, appears to be given by a 'stationary gaussian surface'. There appears to be a spectrum of simple-harmonic waves with the individual wave-fronts having all possible orientations and random phases, the total energy remaining finite. The mathematical expression for such a state is :

$$\eta(x, y, t) = \int_0^{\infty} \int_{-\pi}^{\pi} \cos \left[ \frac{\mu^2}{g} (x \cos \theta + y \sin \theta) - \mu t + \epsilon(\mu, \theta) \right] \sqrt{[A(\mu, \theta)]^2 d\mu d\theta}.$$

The total energy is proportional to :

$$E = \int_0^{\infty} \int_{-\pi}^{\pi} [A(\mu, \theta)]^2 d\mu d\theta = \int_0^{\infty} [A(\mu)]^2 d\mu$$

\* Abstract of a talk delivered at the symposium on "Oceanographic Research and Related Topics" held at the 28th Annual Meeting of the Indian Academy of Sciences, Bombay, December 1962.

$\eta$  is the displacement,  $\mu$  the angular frequency,  $g$  the acceleration due to gravity,  $\theta$  the inclination of the wave-front to the wind direction,  $\epsilon(\mu, \theta)$  the random phase and  $A(\mu, \theta)$  the amplitude of the wave of frequency  $\mu$  and orientation  $\theta$ .

The spectral distribution of  $E$  is not precisely known. Neumann (1953) has suggested a semi-empirical spectrum, though all do not agree with it.

**Forecasting of Ocean-waves.**—As long as non-linear effects can be disregarded, individual waves propagate independent of each other. Deep-water waves are highly dispersive and the wave energy is propagated with the group velocity which is half the phase velocity,  $g/\mu$ .

At any point inside an area of generation of waves, the entire wave spectrum will be present, provided the fetch and the duration of the wind are long enough. The associated wave parameters like the average height, the significant height, 'sun glitter', etc., can be computed once the energy spectrum is known. At any point outside the area of generation, it is possible to estimate for any moment the range of the wave periods present, their total energy and hence the

wave-parameters. Their computation is based on the relation

$$P_a da = \frac{2a}{E} e^{-a^2/E} da$$

where  $P_a da$  is the probability of an amplitude between  $a$  and  $a + da$ , and  $E$  is the amplitude integral

$$\int_{\mu_1}^{\mu_2} [A(\mu)]^2 d\mu.$$

A few wave statistics based on the Neumann spectrum are given in Table I.

TABLE I

Wind in knots	E-value in ft. <sup>2</sup>	Range of periods in secs.		Average amplitude in ft.		At least one wave in 10,000 waves is higher than
		From	To			
10	0.2	1.0	6.0	0.4	1.4	ft. (15 hrs.) †
20	7.7	3.0	11.1	2.5	9	ft. (30 hrs.)
30	58.7	4.7	16.7	6.8	24	ft. (45 hrs.)
40	247	6.5	21.7	14.0	50	ft. (60 hrs.)

† Represents the average time for 10,000 waves to pass a place.

## MEASUREMENT OF RADIATION AND HEAT BALANCE OVER THE INDIAN OCEAN\*

Miss ANNA MANI

**P**RECISE, quantitative measurements of the total energy transferred at the ocean-atmosphere boundary and at the top of the atmosphere are required for a study of the transformation of solar energy into kinetic, potential and chemical energy within the atmosphere. The thermal energy available to the oceans is given by :

$$Q_0 = Q_s - Q_r - Q_e - Q_t$$

where  $Q_s$  is the incoming solar radiation from the sun and sky,  $Q_r$  the solar radiation reflected from the sea surface,  $Q_e$  the latent heat of evaporation and  $Q_t$  the turbulent heat flux into the atmosphere. The thermal energy available to the atmosphere is given by :

$$Q_a = R_{ab} + Q_{ec} + Q_t$$

where  $R_{ab}$  is the energy absorbed in the atmosphere and  $Q_{ec}$  the latent heat of evaporation subsequently released through condensation.  $Q_{ae}$ ,  $Q_s$  and  $Q_e$  are obtained from the determination of vertical fluxes of water vapour, heat and

momentum supplemented by condensation observations.  $Q_s$  and  $R_{ab}$  are measured directly by using pyranometers and radiometers, both ground-based and airborne, supplemented by satellite observations.

The radiation balance at the surface of the earth,  $R$ , is the difference between the absorbed and outgoing radiation,

$$R = Q_s (1 - \alpha) - I$$

where  $\alpha$  is the albedo of the earth and  $I$  the effective outgoing radiation. Measurements of radiation balance and of components of heat balance over the Indian Ocean are planned during the International Indian Ocean Expedition from a network of over 70 land stations and from oceanographic ships, to be supplemented by the meteorological observations over both land and sea.

\* Abstract of a talk delivered at the symposium on "Oceanographic Research and Related Topics" held at the 28th Annual Meeting of the Indian Academy of Sciences, Bombay, December 1962.

## EXPLORING INNER SPACE

E. C. LAFOND

*U.S. Navy Electronics Laboratory, San Diego 52, California*

## INTRODUCTION

**M**ANKIND'S programs for outer space exploration have been publicized by all international media of information. More orbits around the earth, space platforms, and visits to other worlds have been forecast. Landings and stations on the moon and planets of the solar system are under consideration for the future. But this exploration, fascinating though it may be, seems a paradox to oceanographers, who realize the depth of man's ignorance concerning the resources of inner space—the oceans that cover seven-tenths of our planet.

Scientists and technologists who move in the opposite direction from their colleagues in outer space work believe that humanity in general will benefit far more by utilizing the vast and untapped resources of inner space, than through exploration of outer space.

Why should the oceans be studied far more intensively than at present? What does it matter what is below the sea surface? There are many answers to these questions. First—and perhaps most compelling—inner space offers an economic richness of food, minerals, and other resources in a superabundance that has not even begun to be exploited, but which is available to any peoples who will direct scientific effort to obtaining it.

Environmental factors that control the life processes or abundance of sea organisms are as yet not well understood.<sup>1</sup> Cheap and abundant food for the protein-deficient peoples of the world should be a primary objective of any study of the sea.<sup>2</sup>

Another item of economic importance is the mineral wealth contained in the sea-water and on the sea-floor. Most people are aware of the salts of the sea, not only sodium chloride the table salt, but bromides and iodides which are nearly as important. Others of these minerals such as calcium will plate out on the sea-floor. Even more essential are the phosphates and manganese oxides. Their abundance is beyond belief, but technology for recovering them remains inadequate.

Aside from the economic aspects, a knowledge of the sea is necessary for efficient navigation both for commercial and naval ships. The sea

can also offer protection from enemy attacks by serving as a shield against radiation blasts and by providing a means for eluding pursuers. When the situation is reversed and it is the enemy that must be sought out, difficult problems are manifest. The sea is nearly opaque to some types of light and sound, and it must be analyzed closely to establish the best ways of seeing, hearing or sensing through it. Ships must go on top of the water as well as through it. Designing them to travel fast and safely requires a knowledge of such aspects of the sea as viscosity, turbulence, corrosion, waves, tides, currents and other factors that must be determined if optimum efficiency is to be achieved.

A potent but often little-understood objective in a massive exploration of inner space is the acquisition of knowledge, the application of which is not as yet known, but which could be all-important in the future. The characteristics of the subsurface oceans must frequently be determined from the view-point of applied economics or military objectives. In this regard, there has been much discussion about the relative merits of applied *versus* fundamental studies. But until all the facts about the sea are established they cannot be applied for any reason, and no fact has been uncovered so far that is not applicable pragmatically. In the search for information, some objectives have been given priority over others, but the ultimate value of acquired data cannot be known *a priori*.

Without elaborating on all of these needs, we can now consider seven fields of sea exploration along with their methods of implementation. These may be identified as synoptic oceanography; 3-D oceanography; *in situ* underwater visibility; stability for motion studies; deep oceanography; sub-floor structure; and remote areas.

## SYNOPTIC OCEANOGRAPHY

This process can be defined as the study of an ocean variable in many places at the time. The present system for areal coverage is to take a ship, stop at one position, sample the sea and move on to another position for the next sample. Thus a considerable lapse of time transpires



between samples, the sea conditions change, and a simultaneous picture of the particular sea variable cannot be obtained.

One solution is to deploy a hundred or more ships, equally spaced in a grid pattern and sample an area quickly, but this type of operation has proved to be too expensive. A more economic solution is to have small, anchored buoys floating, but unmanned, which sense the variable desired and automatically radio this information to a central station. Experimental buoys are being tested. In the future the ocean

is a three-dimensional picture of some variable, such as the temperature structure in both its horizontal and vertical aspects. The requirement is much more complex than the synoptic picture of the surface temperature since it introduces a third dimension, depth, and is a consideration of space rather than of time.

One procedure for solving the problem is through the use of the towed thermistor chain which gives a nearly two-dimensional picture as the ship tows the vertical string of sensors through the water (Fig. 1).<sup>3</sup> Some additional

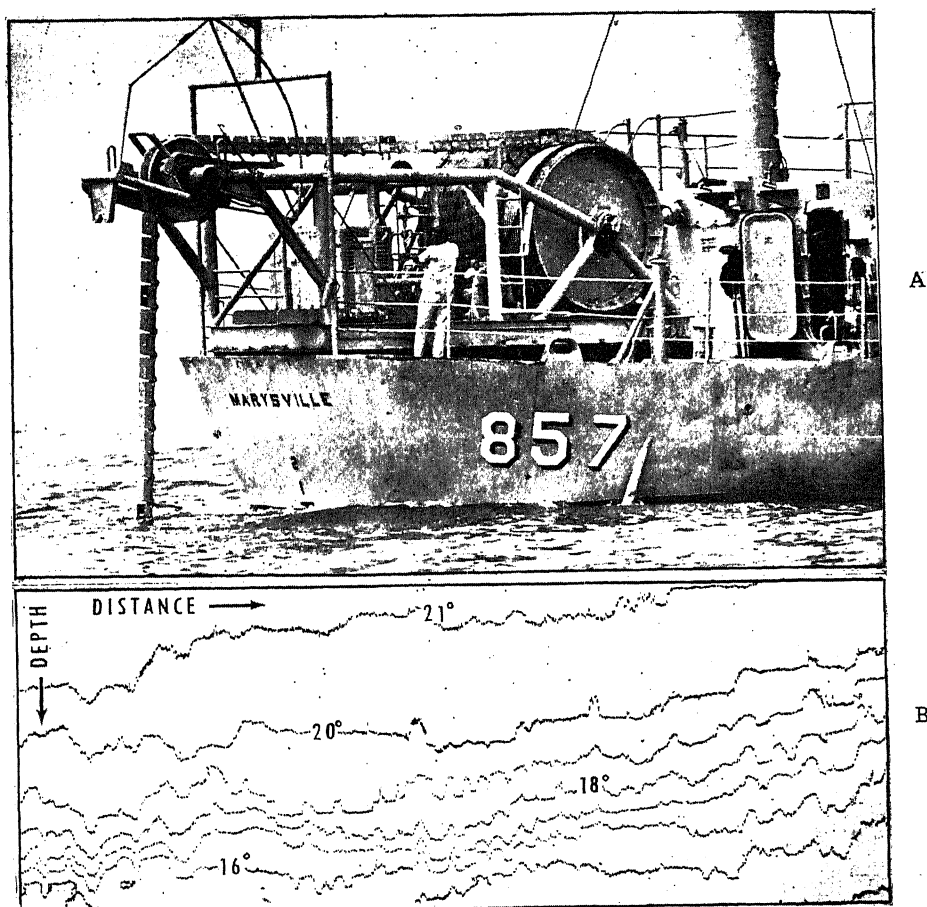


FIG 1. Three-Dimensional Oceanography. A. U.S. Navy Electronics Laboratory's Towed Temperature Profiler. B. Temperature structure record made with the Profiler.

may be peppered with such devices, all sending in information by radio to furnish a synoptic picture.

### 3-D OCEANOGRAPHY

This method of sea exploration is similar to the synoptic approach, but here the requirement

time is involved, but still the ship does not need to stop. The printed record is automatically contoured for isolines by interpolating between sensors. By towing in circles in a network pattern, we can approach a three-dimensional condition.

The most promising solution to the problem, however, may be achieved through use of a scanning technique. A ship can cruise along under favorable conditions, acoustically scan the sea-floor and derive data from which its topography can be obtained. Schools of fish and other biological populations can likewise be delineated by sonar scanners. It is possible

many other factors still utilize visual observation as the most practical technique. A principal problem is how to get the eye close enough to the object under favorable lighting conditions. For shallow water studies, Self-Contained Underwater Breathing Apparatus (SCUBA) is being used extensively to acquire data on marine environment.

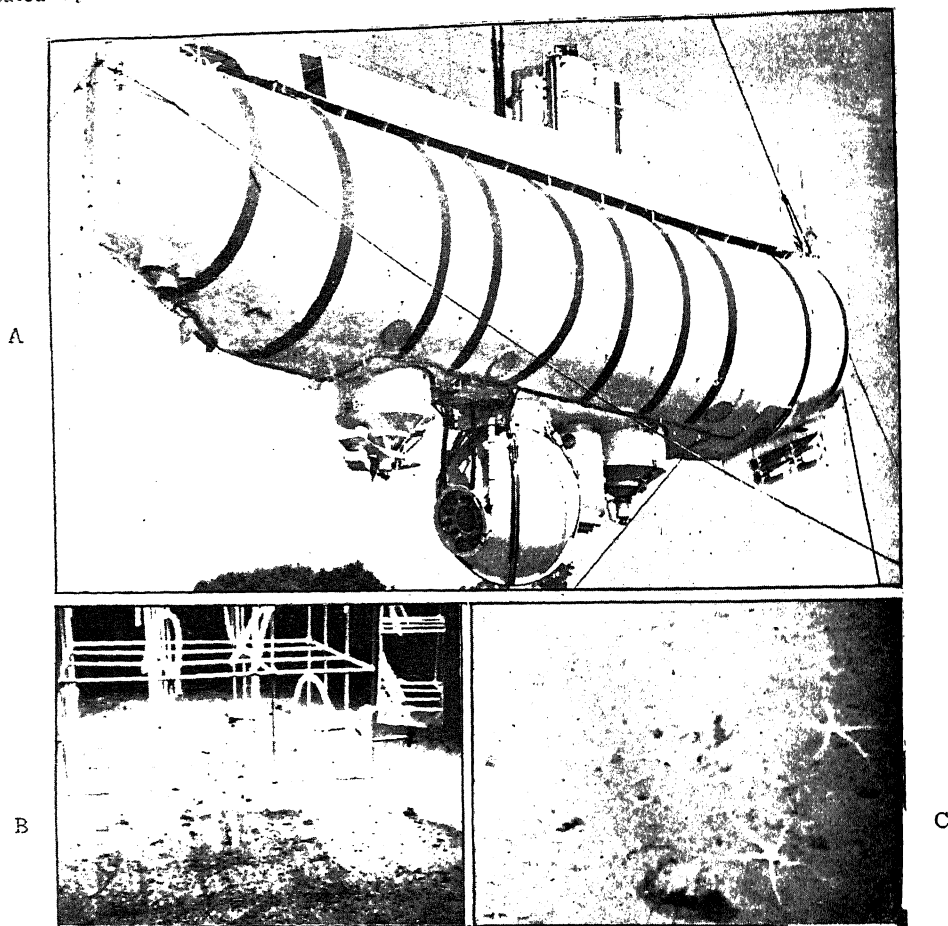


FIG. 2. Deep-Water Oceanography. A. U.S. Navy Electronics Laboratory's Bathyscaph, TRIESTE. B. Deep current measurement equipment used with the TRIESTE. C. Sea-floor organisms photographed from the TRIESTE.

that scanners of the future will be triggered by a given temperature or light intensity and thus present a three-dimensional oceanographic picture.

#### FIRST-HAND, *in situ* UNDERWATER VISIBILITY

Studies of the characteristics of marine organisms and their behavior in the depths of the sea, light and color distributions, micro-relief, sediment movements of the sea-floor, and

One remote system that will achieve this visual aim is the use of closed-circuit underwater television which has already been successfully employed both in shallow water and at great depths in the sea. A television system of this type has been mounted on a remotely controlled tractor that runs along the sea bottom.

Underwater photography, including stereopticon techniques, is used to record sea-floor features. In a water column the organisms are

difficult to identify because of the relative motion and lack of suitable lighting. The solution is to use a submersible to take the observer within close proximity of the object. The bathyscaph<sup>4</sup> and other manned underwater vehicles with suitable lights and windows are making possible the study of many inhabitants and features of the ocean *in situ* (Fig. 2).

#### STABILITY FOR MOTION STUDIES

The study of motion in the sea from an unstable moving ship has been found to be impractical and television studies without stability are unsatisfactory. The only desirable arrangement is a stable platform.

or less. One such 350-foot spar, called Floating Instrument Platform (FLIP), has already been constructed and is now being used as a semi-stable platform by towing it to the desired site and tilting it to a vertical position.

For shipboard use, a large gyro was constructed to resist ship motion. This has been used to study cloud and other sky features at sea. But the most successful device yet used is the oceanographic tower, which is secured to the sea-floor and is presently being used for shallow-water analyses.<sup>5</sup> Such a stable platform is the oceanographic research tower of the U.S. Navy Electronics Laboratory. This tower was installed off Mission Beach, San Diego County,

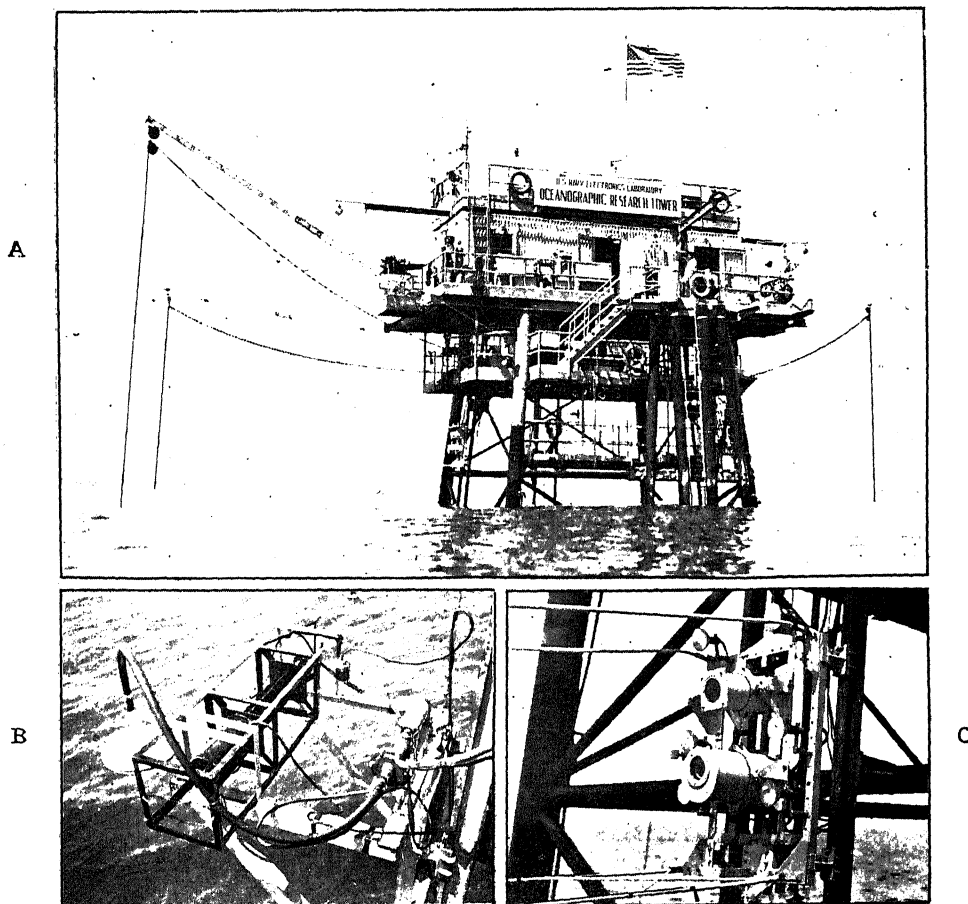


FIG. 3. Stability for Water Motion Studies, A. U.S. Navy Electronics Laboratory's stable Oceanographic Research Tower. B. Water turbidity and sampling equipment on the tower. C. Underwater movie camera and TV on the tower.

One recent technique is to construct a long tube that can be tilted on its end so that it operates as a spar buoy. In this way the vertical surface motion can be damped to 10%

California (U.S.A.) and from it the surface wave motion; internal wave motion; and turbulence are being studied (Fig. 3). With this tower firmly rooted in the sea-floor, it forms

a stable platform for underwater television and motion-picture studies. Planned for the future are other stable reference platforms, including gyro-stabilized floats or even boats.

#### DEEP OCEANOGRAPHY

Deep-water studies are more difficult than other oceanographic investigation because the pressure and remoteness of operation are formidable obstacles not only to entry into these realms but even to the acquisition from the surface of deep-water conditions. The most common procedure is to lower instruments on long, strong, heavy wire rope. Knowledge of their proximity to the bottom and the actual depth of the sensor is, however, often uncertain. The more sophisticated equipments that require long electric cable also offer more drag in the water, are not strong and are subject to leaks. A manned submersible such as a bathyscaph can go to the maximum depth in the sea, but the number of dives per cruise of the present deep submersibles is limited by logistics and can only carry an operator and one or two observers. Other submersibles being planned will be more efficient.

Sensors and recorders can be anchored on the sea-floor; after a prearranged period, a mechanism releases the anchor and allows the recorded data to float to the surface. The preliminary experiments with this technique have not resulted in many readings and recovery of the record is difficult.

A projected means of studying the ocean depths is by unmanned submersibles, much as outer space is now being probed by unmanned space instruments. New deep-diving vehicles are now being tested that can be programmed to go to any depth, make recordings, and return to the mother ship. These are likely to be popular vehicles in the new programs.

#### SUB-FLOOR STRUCTURE

The nature of the sea-floor surface can be determined by echo sounding, photography, visual inspection, bathyscaph observation and bottom samples. These methods, however, do not get much below the water-sediment interface. The first attempt to study the subsurface sediment layers was by means of corers which can penetrate soft sediment up to about 100 feet.

More recently, high-powered acoustic spark signals or explosive signals have been used to penetrate the various layers of sediment and return an echo that identifies the general hardness or reflectivity of the layers and their depth. As a ship moves along, a profile on the sub-

bottom layers is revealed, down to a depth of a mile in some places.<sup>6</sup>

A recent program, termed Project Mohole, attempted to drill a hole in the floor of the sea. An oil-well-drilling barge, positioned by several outboard motors over a given spot in deep-water, operated a long drill into the sea-floor. Project Mohole was only partly successful. Several hundred feet were cored but when hard, basalt material was encountered and no mud-lifting flow and casing could be devised; it was necessary to abandon the operation.<sup>7</sup> When a second and more elaborate program is conducted, it is expected that more information will be revealed about the earth's mantle or sub-floor below the sea. In this case, as in others, technological developments of new oceanographic instruments are badly needed.

#### REMOTE AREAS

In order to save money and in view of the facilities available, there exists a natural tendency for oceanographic investigations to be centered near a home laboratory. In America, for example, the east and west offshore coastal areas of the United States have received the most attention. For similar reasons the Atlantic Ocean has been studied largely by European oceanographers and a large part of the Pacific by Japanese oceanographers. The Arctic Ocean has been either neglected or has received little attention and only lately has the Indian Ocean begun to be systematically explored. Some expeditions to the Arctic Ocean have been conducted in recent years around the fringes of the ice pack by U.S. ice breakers, principally in summer, and a few airplanes have landed on the ice pack during good weather conditions. A technological breakthrough in Arctic Ocean investigations came with the development of the nuclear submarine and its enormous fuel supply and cruising range.<sup>8</sup>

With this formidable addition to the vehicles suitable for oceanographic application to remote areas, if only as a sideline, the entire Arctic Ocean basin can be traversed under the relatively shallow ice cover and underwater studies of it can be made. Such investigations will become more numerous with an increased number of available ships. What is needed most now is a development of additional specialized oceanographic instruments.

The Indian Ocean can be studied from conventional oceanographic vessels. Its former remoteness from oceanographic centers of study mainly accounts for the present relative lack of

knowledge concerning it, but with the accelerated interest in oceanography in India and the other nations of South-East Asia, this situation will not long continue. During the next two years, a concerted effort to be known as the Indian Ocean Expedition will be made to conduct as much work as possible in this area. Twenty-five nations are planning to conduct studies and they are expected to furnish a total of at least forty ships. Much more will be known about this area in the near future.

#### SUMMARY

The most pressing need in the exploration of inner space is a better picture of the sea variables through the medium of synoptic and 3-D structures. It is necessary to go below the surface for a really comprehensive study of ocean life and its environment. Stability in the sea as a reference point from which to carry on motion studies must be achieved. Investigations of the deeper portions of the sea, including the sub-bottom, should be conducted. Finally, a thorough exploration of the least known large bodies of water, the Arctic and Indian Ocean, must be completed.

Many of the solutions to the problems outlined can be found in the development of new techniques and specialized oceanographic equipment. One of the best possibilities is offered

by scanning techniques, especially acoustic for both the water medium and the sub-floor.

The large ocean areas of the earth will receive high-priority study effort in the next few years. The study of inner space will become increasingly implemented as additional tools are developed to extract its secrets for the betterment of humanity. It will be borne out that these investigations of the world's oceans will have greater potentiality for the replenishment of human resources and an enrichment of human life than the widely publicized and spectacular moon program.

1. Hela, Ilmo, *Fisheries Hydrography*, Fishing News, Ltd., London, 1961.
2. Welford, Lionel A., *Living Resources of the Sea*, Ronald Press Company, 1958.
3. LaFond, E. C., "Two-Dimensional Oceanography," *BUSHIPS Journal*, Dec. 1961 **10** (12), 3.
4. Piccard Jacques and Dietz R. S., "Seven Miles Down," *The Story of the Bathyscaphe TRIESTE*, Putnam, 1961.
5. LaFond, E. C., "How it works—The NEL Oceanographic Tower," *U.S. Naval Institute Proceedings*, November 1959, **85** (11), 146.
6. Moore, Dave, G. and Joseph R. Curran, "Structural Framework of the Continental Terrace, North-West Gulf of Mexico," *Journal of Geo-Physical Research* (in press)
7. Bascom, Willard, *A Hole in the Bottom of the Sea*, Doubleday, 1961.
8. LaFond, E. C., "Arctic Oceanography by Submarine," *U.S. Naval Institute Proceedings*, September 1960, **86** (9), 90.

#### ELECTRON-PAIR INTERPRETATION OF THE PION INTERACTION AND THE STRUCTURE OF HEAVY MESONS

THE following is a summary of the paper on the above title presented by E. J. Sternglass of Westinghouse Research Laboratories, before the American Physical Society, New York City, on January 24, 1963.

1. The over-all objective of the present approach has been to explain all the various unstable nuclear particles in terms of as few truly fundamental particles as possible.

2. Among all the known particles, only the electron and its oppositely charged antiparticle of equal mass, the positron, have so far been found to be structureless and stable. Although electrons can be created from radiation or annihilated to form electromagnetic radiation pulses, this happens only in association with the positron, and never when either of the two particles are isolated.

3. Therefore, the basic assumption is to regard the electron-positron pair as the elementary building blocks of matter, including ultimately even the proton and neutron itself,

both of which are now known to contain many unstable particles classified as mesons.

4. The first step in this program was to find the simplest particle that could be constructed from electrons and positrons alone, using only the known laws of electrodynamics and relativity theory (*Physical Review*, July 1961, pp. 391-398). This turned out to be the neutral pi-meson, or pion ( $\pi^0$ ), which was found to be explained in terms of a single electron-positron pair moving in a small hydrogen-like orbit at very high rotational velocity. By allowing the speed to approach practically that of light, the mass of the two electrons increases many-fold over their mass at rest. When this system is given the same basic unit of angular momentum as the hydrogen atom of the Rutherford-Bohr theory, the mass is automatically fixed at some 137 times the mass of two electrons, or  $274 m_0$ . This is very close to the mass of all the so-called pi-mesons, believed to be present in the nucleus and responsible for nuclear forces.

It was found that the resulting neutral structure is energetically unstable, breaking up into light quanta (gamma rays) by the mutual annihilation of the electron and positron in a very small fraction of a second ( $\approx 10^{-16}$  seconds). This new kind of Bohr orbit differs from the hydrogen atom in its vastly smaller size, about  $10^{-13}$  cm. in diameter compared with the hydrogen diameter of  $10^{-8}$  cm., a factor of 100,000 times smaller.

5. The next step in this program, and the one reported in the present paper, was to show that the forces acting between two neutral pions regarded as an electron-positron pair can account for the strength and radius of action of nuclear forces. This is in fact found to be the case, the great strength of the forces being due to the extremely high velocities and close spacings of the electron and positron in the pi-meson system. The charges moving at these velocities give rise to very strong magnetic fields, which act on the rotating charges in an approaching pion so as to attract it only at close range. The effect is to produce forces some 500 times stronger than the ordinary electrostatic or Coulomb force between the same charges at rest.

Because the strength of the force depends on the relative orientation of the two orbits in the two meson systems, it can reach large values only when the particles approach each other to such a degree that their mutual influence can produce the necessary alignments. This explains the extremely short radius of action of these forces, which is quite analogous to the forces between ordinary molecules or atoms which give rise to adhesion and chemical bonding.

6. Once the nature of the force between two pi-mesons had been established, it became possible to construct systems composed of a number of mesons and to compare them with the known properties of the recently discovered heavier mesons.

The first and simplest of these systems is composed of two neutral pi-mesons, and it was found that its calculated mass agrees to within two per cent. with the mass of the neutral K-mesons.

Investigating next the effects of setting this "pionic-molecule" into rotation showed that the first allowed state of rotation according to the rules of quantum mechanics corresponds to an energy or total mass of 766 Mev, or 1500 electron masses ( $m_e$ ). This may be compared with a newly discovered, highly unstable particle that breaks up into two pi-mesons, called the rho-meson, whose mass is  $1495 m_e$  (765 Mev). A whole series of still more energetic unstable

particles composed of two pi-mesons is predicted by the theory, and should appear as the experiments are pushed to still higher energies.

7. Proceeding in a similar manner, it has been possible to construct models of more complex systems containing three, four and five pi-mesons in closely packed clusters. In each case, both the masses of the basic structure and those of its more energetic rotational states have been calculated. For each such system, it has been possible to find observed unstable particles whose masses and rotation moments agree with the appropriate levels. At the present time all the known systems that decay rapidly to pi-mesons have been found to fit to within better than three per cent. to one of the predicted states. These include  $k$ ,  $\omega$ ,  $\rho$ ,  $\xi$ ,  $\alpha$ ,  $\eta$ ,  $f$  and  $\phi$  mesons discovered during the past few years.

A total of 21 separate resonances or particle masses should exist up to the maximum energy investigated so far, and there is now evidence for 19. The remaining two are so close to others that they may have escaped identification as separate states. The mean deviation is less than two per cent.

8. Thus, the original model for the  $\pi^+$  meson has proved itself capable not only of specifying the magnitude of nuclear forces, but also in predicting the existence of an essentially unlimited number of temporary "pionic-molecules" which have been regarded as independent elementary particles.

9. One therefore arrives at a new kind of periodic system for the unstable high-energy particles, analogous to the periodic table of the chemical elements. In both cases, one of the fundamental building blocks appears to be the electron. However, whereas the chemical atoms contain heavy protons as the positive partners to the electron, in the case of the high-energy particles it is the light-weight positron that acts as partner to the electron. Also, whereas the chemical elements have masses that are simply whole multiples of the proton mass, in the case of the nuclear particles the masses represent internal energy of motion that bears no simple integral multiples of the electron-positron mass.

10. Although a detailed model of the proton and neutron that can explain the high stability of these entities is not yet available, there does not seem to be any inherent reason to believe that such models cannot be devised. These two particles are now known to annihilate into mesons, with no other kind of entity being left over, so that one may hope that all matter may eventually be understandable in terms of electrons and positrons alone.—(Westinghouse Press Release.)

## LETTERS TO THE EDITOR

LONG WAVELENGTH  $\pi-\pi^*$   
TRANSITION IN 2, 4-DICHLORO  
BENZALDEHYDE AND 3, 4-DICHLORO  
BENZALDEHYDE

THE near ultra-violet absorption spectra of 2, 4-dichloro benzaldehyde and 3, 4-dichloro benzaldehyde are investigated in vapour phase. The experiments with varied path lengths (50 to 125 cm.) and temperatures (28° to 90°), revealed new absorption band systems in the region  $\nu$  33400 to 33800  $\text{cm}^{-1}$  of moderate intensity. About 18 bands in each could be photographed on the Hilger medium Quartz Spectrograph E. 498. The origins of the electronic transition are fixed at  $\nu$  33606  $\text{cm}^{-1}$  and 33742  $\text{cm}^{-1}$  in 2, 4-dichloro benzaldehyde and 3, 4-dichloro benzaldehyde respectively. A comparative study between these spectra and those of other chloro<sup>(1a, b)</sup> benzaldehydes places the newly observed system in each molecule under the long wavelength benzenoid ring  $\pi-\pi^*$  transition characteristic of aromatic aldehydes. Table I gives the identified excited state fre-

TABLE I

2, 4-Dichloro benzaldehyde	3, 4-Dichloro benzaldehyde	<i>o</i> -Chloro benzaldehyde	<i>m</i> -Chloro benzaldehyde	<i>p</i> -Chloro benzaldehyde	
		1( <i>a</i> )	1( <i>b</i> )	1( <i>a</i> )	1( <i>b</i> )
299	258	279	(292)	305	315
		387	(388)	423	..
455*	457		(469)	544	533
555	703*	468	(711)	..	648
1046	949*	713	(978)	966	778
1090	1091	975	(1068)	..	1052
1170	1169	1060	(1257)	..	1194
1356	1360	1187	..	1344	..

\* Frequencies measured from Microphotometer traces.

quencies together with those established in three other similar aldehydes.

A detailed discussion of the analysis of the spectrum in relation to the Infra-red absorption will be reported shortly.

The authors are indebted to Prof. K. R. Rao for his helpful suggestions. One of the authors

(K. G. S.) is thankful to the University Grants Commission for awarding a scholarship.

Spectroscopy Res. K. G. SREENIVASACHARYA.  
Laboratories, C. SANTHAMMA.  
Physics Dept., Andhra University,  
Waltair, December 19, 1962.

1. (a) Patel, J. C., *J. Sci. & Ind. Res.*, 1959, **18 B**, 265.  
(b) Achyuta Rao, I., *Ibid.*, 1961, **20 B**, 523.

NOTE ON 5- LEVELS IN EVEN-EVEN  
NUCLEI

3- LEVELS of even-even nuclei have been recently interpreted as due to octupole vibrations of the even-even core. It is the purpose of this note to examine the available data on the 5- levels of even-even nuclei and to see if one can interpret them in terms of a  $\lambda=5$  collective vibration.

In Table I are collected the known nuclei which exhibit 5- excited states over the mass number range 90-210.

TABLE I

5- levels of even-even nuclei

Nucleus	Level (Mev.)
Zr- 90	2.32
Cd-108	(2.54)
Cd-110	2.92
Sn-118	2.29
Sn-120	2.29
Xe-130	2.34
W-182	1.62
Pb-206	2.8
Pb-202	2.04
Pb-208	3.2, 3.71
Po-210	2.91

The following remarks may be made:—

1. The excitation energy of these levels varies very little with mass number similar to the 3- levels suggesting some sort of core excitation.

2. No 5- level is definitively known for  $A < 90$ . This is consistent with a breakdown of collective motion characterized by a given number of nodes when the corresponding wavelength at the nuclear surface becomes comparable with or less than the internucleon distance.

3. If the proposed vibrational description of the 5 states is correct, excitation of these states

should be possible and in fact favourable by inelastic electron scattering, and lastly

4. It would be interesting to look for more of these states guided by the above-mentioned systematics.

Department of Physics, M. K. RAMASWAMY,  
Karnatak University,  
Dharwar-3, November 12, 1962.

### MEAN AMPLITUDES OF VIBRATION FOR THE HEXAFLUORIDES OF MOLYBDENUM AND RHENIUM

THE hexafluorides of molybdenum and rhenium possess the octahedral structure with the symmetry point group  $O_h$ . The vibrational spectra of molybdenum hexafluoride were previously studied by Gaunt<sup>1</sup> and Burke, Smith and Nielsen<sup>2</sup> and rhenium hexafluoride by Gaunt<sup>3</sup> but the frequency  $\nu_4$  was not correctly assigned

by them due to the impurity in both cases. Recently Claassen, Selig and Malm<sup>4,5</sup> have studied the Raman as well as infra-red spectra of these two molecules and the reassigned fundamental frequencies (in  $\text{cm}^{-1}$ ) are as follows: 741 ( $A_{1g}$ ), 643 ( $E_g$ ); 741 ( $F_{1u}$ ), 264 ( $F_{1g}$ ), 306 and 190 ( $F_{2g}$ ) for molybdenum hexafluoride and 755 ( $A_{1g}$ ), 596 ( $E_g$ ); 715 ( $F_{1u}$ ), 257 ( $F_{1g}$ ), 246 ( $F_{2g}$ ) and 193 ( $F_{2u}$ ) for rhenium hexafluoride. These authors have also calculated the molar thermodynamic functions for these two molecules. These fundamental frequencies have been taken in the present investigation for the study of mean amplitudes of vibration.

Recently Nagarajan<sup>6</sup> has studied the mean amplitudes of vibration for twelve molecules of this  $XY_6$  type where he has given a detailed analyses of vibrational spectra, construction and orientation of symmetry co-ordinates, kinetic energy matrices, mean-square amplitude

TABLE I  
Symmetrized mean-square amplitude matrices in  $\text{\AA}^2$  for the hexafluorides of molybdenum and rhenium

Molecule	Element	Symmetrized mean-square amplitude matrix			
		T = 0		T = 298° K.	
		MoF <sub>6</sub>	ReF <sub>6</sub>	MoF <sub>6</sub>	ReF <sub>6</sub>
MoF <sub>6</sub> /ReF <sub>6</sub>	$\Sigma_{11}$	0.0011967	0.0011746	0.0012736	0.0012500
	$\Sigma_{22}$	0.0013792	0.0014879	0.0017146	0.0016751
	$\Sigma_{33}$	0.0026735	0.0029568	0.0052556	0.0051513
	$\Sigma_{44}$	0.0067904	0.0050154	0.0080247	0.0074743
	$\Sigma_{34}$	0.0005926	0.0009976	0.002482	0.0030846
	$\Sigma_{55}$	0.0115922	0.0169542	0.0203513	0.0287497
	$\Sigma_{66}$	0.0093348	0.0091897	0.0230509	0.0198865

TABLE II  
Mean-square amplitude quantities in  $\text{\AA}^2$  for molybdenum hexafluoride and rhenium hexafluoride

Symbol	Mean-square amplitude quantity			
	T = 0		T = 298° K.	
	MoF <sub>6</sub>	ReF <sub>6</sub>	MoF <sub>6</sub>	ReF <sub>6</sub>
$\sigma_r$	0.0019953	0.0021701	0.0033439	0.0033424
$\sigma_{rr}$	-0.0000304	-0.0000522	-0.0009402	-0.0000709
$\sigma_{rr'}$	-0.0006776	-0.0007867	-0.0019097	-0.0008090
$\sigma_\theta$	0.0064456	0.0078450	0.0113307	0.0136260
$\sigma_{\theta\theta}$	-0.0003181	-0.0005218	-0.0018720	-0.0015516
$\sigma_{\theta\theta'}$	-0.00032818	-0.00041834	-0.0066014	-0.0075888
$\sigma_{\theta\theta''}$	0.0003181	0.0005218	0.0018720	0.0015516
$\sigma_{\theta\theta''}$	-0.00016170	0.0007424	-0.0041521	-0.000538
$\sigma_{r\theta}$	-0.0001482	-0.0002494	-0.0006121	-0.0007714
$\sigma_{r\theta'}$	0	0	0	0
$\sigma_{r\theta''}$	0.0001482	0.0002494	0.0006121	0.0007712
$\sigma_d$	0.0001340	0.0005140	0.0085017	0.0112430
$\sigma_{dd}$	0.0006450	0.0004964	0.0001636	0.0000180
$\sigma_{dd'}$	-0.0000072	0.00000386	0.000230	0.0005362
$\sigma_{rd}$	0.0012850	0.0012214	0.0019054	0.0017679
$\sigma_{rd'}$	-0.0003958	-0.0004166	-0.0009460	-0.0007839



matrices, analytical expressions for the mean-square amplitude quantities and secular equations for the normal frequencies. Hence they need not be repeated here. Only the results of the present investigation have been reported.

TABLE III

Mean amplitudes of vibration in Å for the hexafluorides of molybdenum and rhenium

Molecule	Distance	Mean amplitude of vibration	
		T = 0	T = 298° K.
MoF <sub>6</sub>	Mo-F	0.0447	0.0578
	F..F	0.0717	0.0922
ReF <sub>6</sub>	Re-F	0.0466	0.0579
	F..F	0.0743	0.1061

There are, to the author's knowledge, no experimental values from the electron diffraction study for the comparison of the values of the present investigation.

It is a great pleasure for the author to express his sincere thanks to the Council of Scientific and Industrial Research, Government of India, for the award of a senior research fellowship.

Department of Physics, G. NAGARAJAN,\*  
Annamalai University,  
Annamalainagar, November 22, 1962.

\*Present address: Postdoctoral Fellow, Department of Chemistry, Oklahoma State University, Stillwater, Oklahoma, U.S.A.

1. Gaunt, J., *Trans. Farad. Soc.*, 1953, **49**, 1122.
2. Burke, T. G., Smith, D. F. and Nielsen, A. H., *J. Chem. Phys.*, 1952 **20**, 447.
3. Gaunt, J., *Trans. Farad. Soc.*, 1954 **50**, 209.
4. Claassen, H. H., Slig, H. and Malm, J. G., *J. Chem. Phys.*, 1962, **46**, 988.
5. —, Malm, J. G. and Selg, H., *Ibid.*, 1962, **36**, 2890.
6. Nagarajan, G., *Bull. Soc. Chim. Belg*, 1962, **71** (in press).

### SIMPLE EXERCISE TO VERIFY THE DEBYE-HUCKEL LIMITING LAW FOR THE ACTIVITY COEFFICIENTS OF STRONG ELECTROLYTES

IN this communication an attempt has been made to verify the Debye-Hückel law of activity coefficients of strong electrolytes from the simple acid-base potentiometric titration, with which most of the students are familiar.

According to this theory, which is expressed as,

$$-\log_{10} \gamma_i = A Z_i^2 \sqrt{\mu},$$

the mean activity coefficient  $\gamma_i$  of an ion in a very dilute electrolyte solution is dependent on the ionic strength of the solution. Hence, if we

keep the ionic strength of the electrolyte solution constant, the mean activity coefficient of the particular ion remains constant even if its stoichiometric concentration is changed. This can be very easily tested by setting up a cell.

Pt      HCl Solution saturated      Saturated      Calomel  
          with quinhydrone      KCl      cell

and determining the E.M.F. after each addition of NaOH solution to HCl solution in the left-hand compartment. The liquid junction potential in this case can be safely assumed to be negligible and the activity of H<sup>+</sup> ions can be calculated by using the Nernst's equation. Calculating the stoichiometric concentration of H<sup>+</sup> ions in solution after each addition of NaOH, we can determine the mean activity coefficient  $\gamma_i$ . This activity coefficient can be shown to remain constant throughout the titration, as the total ionic strength of the solution remains constant, HCl being replaced by NaCl only. NaOH solution taken for such a purpose should be at least ten times more concentrated than the HCl solution, so that the effect of dilution is negligible.

In the experiment conducted in this laboratory 0.01 M. HCl was initially taken and NaOH of 0.1 M. strength was added by an accurate microburette. The E.M.F. of the cell before and after each addition of NaOH solution was noted on a 0.1 mV. sensitive potentiometer. Temperature was kept constant at 25° ± 0.1° C. throughout the measurement. HCl and NaOH solutions were accurately standardised previously. The results are given in Table I.

TABLE I

Conc. of HCl				= 0.01052 M.		
Conc. of NaOH				= 0.09389 M.		
50 ml. of HCl solution +				.... ml. of NaOH		
... ml. of NaOH added	Conc. of NaOH in final Sol. ... mM	Conc. of HCl due to dilution ... mM	Conc. of H <sup>+</sup> ions C <sub>H<sup>+</sup></sub> ... mM	E.M.F. ... V	Activity of H <sup>+</sup> ions a <sub>H<sup>+</sup></sub> ... mM	Mean activity coeff ... γ <sub>i</sub>
0.0	0.001	10.52	10.52	0.3334	9.506	0.9036
0.5	0.02	10.41	9.481	0.3307	8.570	0.9040
1.0	1.841	10.30	8.459	0.3278	7.656	0.9050
1.5	2.735	10.21	7.475	0.3245	6.808	0.9086
2.0	3.611	10.11	6.499	0.3210	5.861	0.9020
2.5	4.447	10.01	5.563	0.3171	5.046	0.9071
3.0	5.314	9.919	4.605	0.3123	4.178	0.9072
3.5	6.142	9.826	3.684	0.3066	3.342	0.9073
4.0	6.955	9.736	2.781	0.2993	2.518	0.9054
4.5	7.752	9.647	1.895	0.2889	1.722	0.9032
5.0	8.535	9.559	1.024	0.2731	0.9311	0.9095

Chemistry Department;  
Institute of Science,  
Bombay-1, July 16, 1962.

V. N. DAMLE.  
A. G. DESAI.

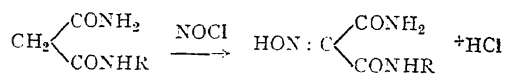
# ISONITROSO DERIVATIVES OF MALON-MONO ARYLAMIDES USING NITROSYL CHLORIDE AS A NITROSATING AGENT

COMPOUNDS having an active methylene group react with nitrous acid to form oximino derivatives. The attack on the  $\alpha$ -methylene group of ketones is illustrated by the action of ethyl nitrite on propiophenone to form biacetyl monoxime<sup>1</sup> and isonitrosopropiophenone<sup>2</sup> respectively.

Similarly the  $\alpha$ -methylene group of acetoacetic ester<sup>3</sup> is oximinated by the action of sodium nitrite in glacial acetic acid. Nitrosation of alkylated malonic,<sup>4</sup> acetoacetic,<sup>5</sup> benzoyl<sup>6</sup> acetic esters with subsequent cleavage affords an excellent synthesis of  $\alpha$ -oximino esters. If a  $\beta$ -keto acid is nitrosated then the carboxyl group is lost and  $\alpha$ -oximino ketone<sup>7</sup> is formed.

Naik<sup>8</sup> and his collaborators have studied the reactivity of hydrogen atoms of compounds containing reactive methylene group situated between the two carbonyl groups—(CO-CH<sub>2</sub>-CO) and also prepared the oximes of aceto-acet-aryl amides using nitrosyl chloride.

Here in the present work the nitrosation by means of nitrosyl chloride with malon-mono arylamides is reported. The structure given below is confirmed on the analysis of nitrogen of nitroso derivatives, melting points and yellow coloured crystals.



where R is phenyl, tolyl, xylyl and naphthyl groups.

Nitrosyl chloride in this case does not behave as a chlorinating agent but it acts as a nitrosating agent as seen from the researches carried out by Solanina, Tilden and others.<sup>9</sup>

## EXPERIMENTAL

1.7 g. of malon-mono-aryl amide (1 mol.) is suspended in chloroform in a flask surrounded by ice-water into which dry nitrosyl chloride gas generated by the action of anhydrous aluminium chloride (1 mol.) and sodium nitrite (1 mol.) is passed slowly by continuous shaking till the reaction mixture is saturated when it became deep reddish-yellow in colour. The reaction mixture was then refluxed on a water-bath to remove excess of the gas and then was transferred to an evaporating dish when a solid yellow product was obtained. It was then recrystallised from suitable solvents (alcohol, chloroform, benzene, etc.) into shining yellow needles.

One of the authors (P. L. Parimoo) is thankful to M.S. University of Baroda for a research scholarship.

Chemistry Department,  
Faculty of Science,  
M.S. University of Baroda,  
Baroda, July 1, 1962.

C. M. MEHTA.  
P. L. PARIMOO.

1. Semon and Demerell, *Org. Synthesis*, 1943, Col. Vol. 2, 204.
2. Hartung and Crossley, *Ibid.*, 1943, Col. Vol. 2, 363.
3. Adkins and Reeve, *J. Am. Chem. Soc.*, 1938, 60, 1328.
4. Shivers and Hauser, *Ibid.*, 1947, 69, 1264.
5. Barry and Hartung, *J. Org. Chem.*, 1947, 12, 460; Weaver and Hartung, *Ibid.*, 1950, 15, 741.
6. Hauser and Raynolds, *J. Am. Chem. Soc.*, 1948, 70, 4250.
7. Wieland, *Ber.*, 1907, 40, 1677.
8. Naik, *J. Ind. Chem. Soc.*, 1943, 20, 384; *J. Chem. Soc.*, 1921, 119, 379; 1921, 119, 1231, 2592.
9. Solanina, *J. Russ. Phys. Chem. Soc.*, 1899, 30, 437; Tilden, *J. Chem. Soc.*, 1895, 67, 486; Vitherey, *Ibid.*, 1894, 65, 521.

## GRAVIMETRIC DETERMINATION OF ZIRCONIUM (AND THORIUM) USING N-PHENYL GLYCINE, SUCCINIC ACID AND ADIPIC ACID

2,5-DIHYDROXY *p*-benzoquinone has been reported as a selective reagent for the gravimetric determination of zirconium and thorium.<sup>1,2</sup> Succinic and adipic acids have been reported to completely precipitate thorium.<sup>3</sup> It has now been found that N-phenyl glycine completely precipitates zirconium and thorium in the pH range 2.0-3.8 and 3.8-4.0 respectively. Malonic acid precipitates zirconium incompletely, while succinic and adipic acids bring about its complete precipitation in the pH range 3.0-3.5 and 2.0-3.5 respectively.

*Gravimetric determination of zirconium and thorium using N-phenyl glycine.*—N-phenyl glycine was prepared from chloroacetic acid and aniline by the method employed by Houben.<sup>4</sup> 0.5-1 gm. of N-phenyl glycine was added to 100-150 ml. of a solution containing about 10 mg. of thorium or zirconium oxide and the pH of the solution adjusted with the addition of hydrochloric acid or ammonia. The solution was boiled for 1-2 minutes, cooled to room temperature and then filtered through Whatman filter-paper No. 40. The precipitate was washed with a 1% aqueous solution of N-phenyl glycine (adjusted to the same pH as the experimental solution), dried and ignited to oxide. The results obtained during determination of zirconium and thorium are given in Tables I and II respectively.

TABLE I

 $ZrO_2$  taken (oxine method) = 12.8 mg.

$ZrO_2$ found, mg. (using N-phenyl glycine)	6.5	11.9	12.8	12.8	12.8	12.8	12.8
pH	..	1.0	1.7	2.0	2.5	3.0	3.5 3.8

TABLE II

 $ThO_2$  taken (oxine method) = 9.0 mg.

$ThO_2$ found, mg. (using N-phenyl glycine)	1.6	2.2	5.2	9.0	9.0
pH	..	3.0	3.2	3.5	3.8 4.0

Gravimetric determination of zirconium using malonic, succinic and adipic acids.—The procedure used was similar to that described above. The results obtained during the determination of zirconium using malonic, succinic and adipic acids are given in Tables III, IV and V respectively.

TABLE III

 $ZrO_2$  taken (oxine method) = 8.5 mg.

$ZrO_2$ found, mg. (using malonic acid)	6.5	7.0	7.3	5.0	2.5	No ppt.
pH	..	1.1	1.6	2.0	2.4	2.8 3.0-4.0

TABLE IV

 $ZrO_2$  taken (oxine method) = 8.5 mg.

$ZrO_2$ found, mg. (using succinic acid)	7.0	7.8	8.5	8.5
pH	..	2.2	2.5	3.0 3.5

TABLE V

 $ZrO_2$  taken (oxine method) = 8.5 mg.

$ZrO_2$ found, mg. (using adipic acid)	5.8	7.2	8.5	8.5	8.5	8.5
pH	..	1.0	1.5	2.0	2.5	3.0 3.5

Thanks are due to Professor T. R. Seshadri, F.R.S., Head of the Department, for helpful discussions.

Department of Chemistry,  
University of Delhi,  
Delhi-6, December 19, 1962.

B. D. JAIN.  
S. P. SINGHAL.

1. Jain, B. D. and Singhal, S. P., *Talanta*, 1960, **4**, 178.
2. —, *J. Inorg. Nucl. Chem.*, 1961, **19**, 176.
3. Suryanarayana, T. V. S. and Rao, B. S. V. R., *J. Ind. Chem. Sec.*, 1951, **28**, 511.
4. Houben, J., *Ber.*, 1913, **47**, 3988.

## DETERMINATION OF BERYLLIUM AS OXIDE BY HOMOGENEOUS PRECIPITATION TECHNIQUE

We have observed in this investigation that if precipitation is carried out by generating ammonia *in situ* by the hydrolysis of urea<sup>1</sup> in the presence of ammonium sulphate, dense and easily filterable precipitate is obtained which on ignition gave quantitative yield of beryllium oxide. The procedure recommended is as follows: To a solution containing about 30 to 60 mgm. of beryllium, add 2 gm. of ammonium sulphate, 10 gm. of ammonium chloride and 10 gm. of urea and make up the volume to 500 ml. Heat the solution on a hot plate till opalescence appears (about 60 minutes). Boil the solution for two hours, keeping the volume of the solution constant by adding distilled water from time to time. Then place the beaker on a boiling water-bath for one hour, and collect the precipitate on a close texture quantitative filter-paper (Whatman 42). Transfer the precipitate along with the filter-paper into a weighed platinum crucible. Ignite the precipitate to constant weight at about 1,000°C. Transfer the crucible to a desiccator and weigh the beryllium oxide obtained.

A representative set of results obtained by employing the above procedure is given in Table I.

TABLE I

No.	Beryllium Oxide taken gm.	Beryllium Oxide found gm.	Error mg.
1	0.1598	0.1597	-0.10
2	0.1456	0.1456	0.00
3	0.0941	0.0939	-0.20
4	0.0788	0.0787	-0.10

Details will be published elsewhere.

Chemical Laboratories, T. P. PRASAD.  
Andhra University, M. N. SASTRI.  
Visakhapatnam-3, August 20, 1962.

1. Willard, H. H. and Tang, N. K., *J. Am. Chem. Soc.*, 1937, **59**, 1190.

## REDUCTION OF ISOFLAVONES WITH SODIUM BOROHYDRIDE

In a recent note<sup>1</sup> it has been shown, that sodium borohydride reduces flavanones to give 4- $\beta$ -axial hydroxy flavans. During a study of the action of this reagent over isoflavones similar stereo-specificity is also noticed. 7-Methoxy and 7:4'-dimethoxy isoflavones (Ia, 1b) were reduced with sodium borohydride in 95% ethanol at laboratory temperature. Isoflavan-4-ols (IIIa, IIIb) were obtained as colourless crystalline

compounds in good yields (80-85%). The same compounds were also obtained when 7-methoxy and 7:4'-dimethoxy isoflavanones (II *a*, II *b*) were reduced with sodium borohydride. The yield of these products was not improved by addition of boric acid to the reaction mixture. The structure of these compounds is further established by their ready formation of acetyl derivatives. They are thus 7-methoxy, 7:4'-dimethoxy isoflavan-4-ols (III *a*, III *b*). It is significant to note that during sodium borohydride reduction, the pyrone double bond is also reduced. Similar observations were previously recorded by Seshadri *et al.*<sup>2</sup> and Miyano and Matsui.<sup>3</sup> Reduction of a simple flavone with sodium borohydride was ineffective and the

original compound was recovered. These observations will naturally point out the different influences of the phenyl groups in flavones and isoflavones; in the former the C=O and the pyrone double bond are in a continuous conjugated system with the two phenyls, and the 3-phenyl group in the later is no longer conjugated with the C=O group.

During the reduction of 2-methyl 7-methoxy and 2-methyl 7:4'-dimethoxy isoflavones with sodium borohydride at laboratory temperature, major quantity of the starting isoflavones was recovered unchanged. When the reduction was carried out at 80° a colourless liquid was obtained which could not be crystallised and which gave liquid acetyl and benzoyl derivatives.

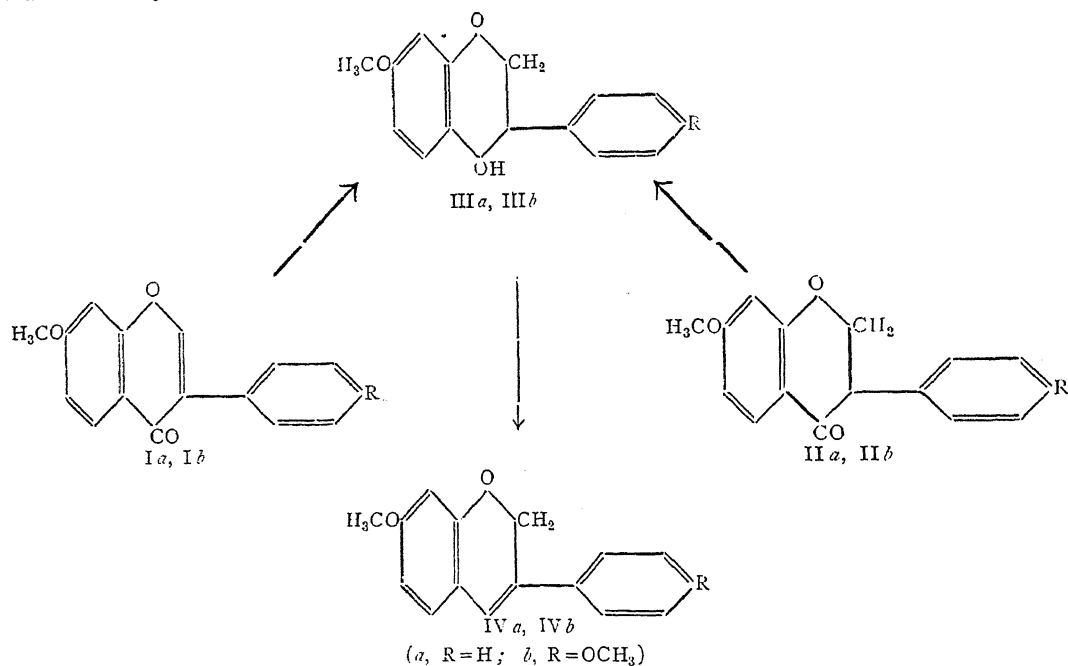
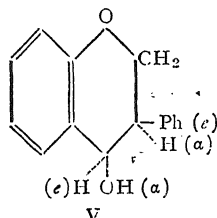


TABLE I

Compound	mp.	Formula	Required	Found	Colour in conc. H <sub>2</sub> SO <sub>4</sub>	Colour in conc. HCl
1. 7-Methoxy isoflavan-4-ol	.. 138-40°	C <sub>16</sub> H <sub>16</sub> O <sub>3</sub>	75.01 6.25	74.66 7.12	Yellow with green fluorescence	Yellow
Acetate	.. 116-18°	C <sub>18</sub> H <sub>18</sub> O <sub>4</sub>	72.49 6.04	72.95 6.57		
2. 7:4'-Dimethoxy isoflavan-4-ol	.. 141-43°	C <sub>17</sub> H <sub>16</sub> O <sub>4</sub>	71.32 6.29	71.5 7.37	Orange red	Yellow
Acetate	.. 121-23°	C <sub>19</sub> H <sub>20</sub> O <sub>5</sub>	69.50 6.09	69.93 6.83		
3. 7-Methoxy isoflav-3-en	.. 105-07°	C <sub>16</sub> H <sub>14</sub> O <sub>2</sub>	80.68 5.88	81.34 6.17	Yellow with green fluorescence	Yellow
4. 7:4'-Dimethoxy isoflav-3-en	.. 160-61°	C <sub>17</sub> H <sub>16</sub> O <sub>3</sub>	76.12 5.97	75.68 6.70	Yellow	Pale yellow

The fourth hydroxyl in the isoflavan-4-ols may be expected to possess  $\beta$ -axial configuration. This is confirmed by the ease with which these compounds suffered dehydration with phosphorus oxychloride-pyridine or with glacial acetic acid containing a trace of HCl to give isoflav-3-enes (IV a, IV b). It is well known that dehydration by these reagents is caused when the elements of water are trans-situated. Therefore the 3-H and 4-OH are both trans-axial leaving the 3-phenyl group equatorially oriented. This is what may be expected from the well-known rule<sup>1,5</sup> that the heavier phenyl group usually orients itself in equatorial direction. The steric configuration of the isoflavan-4-ol (V) is, therefore, similar to that of a flavan-4-ol proposed by Bognar *et al.*<sup>5</sup>



Our grateful thanks are due to the University Grants Commission for awarding a Junior Research Fellowship to one of us (A. S. R.).

Dept. of Chemistry, L. RAMACHANDRA ROW.  
Andhra University, A. S. R. ANJANEYULU.  
Waltair; C. SRI KRISHNA.  
November 28, 1962.

1. Ramachandra Row, L., Purnananda Sastry, G., Subba Rao, P. V. and Gopala Rao, M., *Cur. Sci.*, 1962, **31**, 459.
2. Aghoramurthy, K., Kulka, A. S. and Seshalri, T. R., *Ibid.*, 1961, **30**, 218.
3. Masateru Miyano and Masanao Matsumi, *Chem. Ber.*, 1958, **91**, 2044.
4. Borton, D. H. R., *Chem. and Ind.* 1954, p. 21.
5. Bognar, R. *et al.*, *Tetrahedron*, 1962, **18**, 135.

### AMPEROMETRIC DETERMINATION OF GOLD WITH THIOUREA

THIOUREA and its derivatives have been used for the detection and determination of various metal ions which are good sulphur co-ordinators.<sup>1</sup> It has now been observed that thiourea forms a complex with gold (III) in a pH range 3 to 5. Advantage of this is taken for the amperometric determination of gold.

**Procedure.**—Approximately 0.003 M.  $\text{AuCl}_3$  solution was prepared by dissolving about 0.3 to 0.4 gm. of gold in *aqua-regia*. This was evaporated to dryness nearly three or four times,

in the presence of sodium chloride, with conc. HCl. The residue was redissolved in dilute HCl and made up to 500 ml. Exactly 0.1 M. thiourea solution was prepared by dissolving 1.903 gm. of E. Merck sample in 250 ml. of distilled water. The titrations were carried out at the rotating platinum micro-electrode at a potential of  $-0.1$  volt vs. S.C.E. at room temperature ( $\sim 21^\circ\text{C}$ ).

Aliquot of  $\text{AuCl}_3$  solution was taken in a 100 ml. pyrex beaker and the pH of the solution was raised to 4.5 by dropwise addition of a saturated solution of (E. Merck) sodium bicarbonate. The contents of the beaker were diluted to about 25–30 ml. and titrated with 0.01 M. thiourea solution, the latter being added through a micro-burette. The current, indicated by the galvanometer deflections, first decreased and became constant after the end point. A typical representation of the curve is shown in Fig. 1.

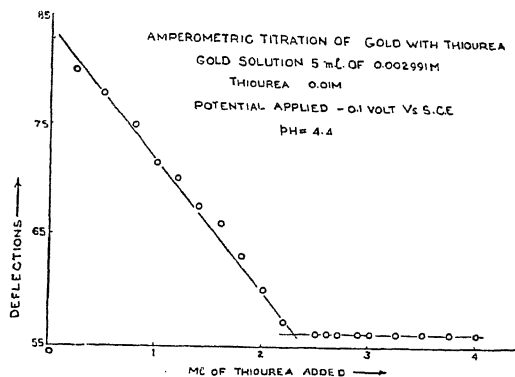


FIG 1

The results indicated that 2 moles of gold combine with 3 mols of thiourea in the present reaction. Using this method, as low as 0.1–0.2 mg. of gold can be determined with sufficient accuracy.

Sincere thanks of the authors are due to Prof. G. B. Singh for interest and facilities. The award of a Senior Research Fellowship by the C.S.I.R., to one of us (S. V. T.), is also gratefully acknowledged.

Analytical Chem. Section, G. S. DESHMUKH.  
Department of Chemistry, S. V. TATWAWADI.  
Banaras Hindu University, M. SURENDRANATH.  
Varanasi-5, October 12, 1962.

1. Yoe, J. H. and Overholser, L. G., *Ind. Eng. Chem. Anal.*, 1942, Ed. **14**, 435.

PHYTOCHEMICAL STUDIES ON THE  
GENUS *CROTALARIA*  
PART II. IDENTITY OF SERICINE AS  
SPECTABILINE (ACETYL  
MONOCROTALINE)

*Crotalaria* species have evoked world-wide interest in recent years on account of their poisonous properties. In a previous communication<sup>1</sup> isolation of two alkaloids was reported from *Crotalaria sericea*. One of these was identified as monocrotaline while the other obtained in very low yields was tentatively considered as a new alkaloid and named sericine. The alkaloid monocrotaline was found<sup>2</sup> to possess hypotensive properties and also produces a marked contraction of smooth musculature, especially of uterus and intestines.

Neal, Rusoff and Ahmann<sup>3</sup> isolated a single alkaloid monocrotaline from *C. spectabilis*, which is sometimes considered as synonym of *C. sericea*. Culvenor and Smith<sup>4</sup> recently isolated monocrotaline and spectabiline from the same species.

Since the first communication<sup>1</sup> in this series, the authors were able to prepare larger quantities of sericine by an improved method and, therefore, investigations on structure of sericine were undertaken and it was found to be identical with spectabiline.

Seeds (4.0 kilo) freed from testa and horny endosperm were extracted with alcohol, the solvent distilled off and the resulting dark-brown semi-liquid mass treated with dilute sulphuric acid. The filtered acid extract was washed with chloroform, then made alkaline with dilute solution of ammonia and extracted with ether and chloroform. Ether extract gave sericine (3.8 g.), m.p. 180–81°, while the chloroform extract gave crude base which on crystallisation from ethanol gave monocrotaline (9.9 g.), m.p. 195–96°.

The crude base mother liquor was evaporated and the residue crystallized from acetone-light petroleum and ethanol to give a further quantity of colourless prisms of sericine (3.5 g.), m.p. 180–81° (total yield 0.18% of air-dried seeds).  $[\alpha]_D^{30} + 123$  (C. 1.7 in chloroform),  $[\alpha]_D^{30} + 141$  (C. 1.38 in ethanol), reported<sup>4</sup> for spectabiline  $[\alpha]_D^{30} + 121$  (C. 1.7 in chloroform);  $[\alpha]_D^{30} + 143$  (C. 1.38 in ethanol). Anal. (found C. 58.8; H. 6.77; N. 3.9%; Eq. wt. 370. Calc. for  $C_{18}H_{25}O_7$  N, C. 58.9; H. 6.8; N. 3.7%. Eq. wt. 367). Alkaline hydrolysis of sericine (1.0 g.) under the conditions described by Culvenor and Smith<sup>4</sup> gave retronecine hydrochloride, m.p.

161–62° (reported<sup>1</sup> for retronecine hydrochloride 164–65°).

The acid hydrolysis of sericine under the conditions described by Culvenor and Smith<sup>4</sup> gave monocrotaline, m.p. 195–96° (reported<sup>4</sup> 204–05°).

Prolonged acid hydrolysis of sericine was carried out by refluxing 0.5 g. of sericine with hydrochloric acid (10% ; 16 ml.) for 8 hours. After cooling the solution, monocrotalic acid was extracted continuously with ether. On evaporation of ether white solid was obtained which was crystallised from acetone-light petroleum to give monocrotalic acid. m.p. 176–78° (reported<sup>4</sup> 182–83°).

Finely powdered monocrotaline (3 g.) on acetylation by refluxing it with acetyl chloride gave pure sericine, m.p. 180–81° (reported<sup>4</sup> for spectabiline 185–86°).

The above data show that sericine on alkaline hydrolysis gives retronecine, on mild acid hydrolysis gives monocrotaline and on prolonged acid hydrolysis monocrotalic acid. On the other hand acetylation of monocrotaline gives a compound identical with sericine. This proves that sericine is acetyl monocrotaline and is, therefore, identical with the spectabiline of Culvenor. A mixture of spectabiline supplied by Dr. Culvenor, and sericine isolated by us gave a single spot on paper chromatogram and no depression in m.p. showing their identical nature. Hence in view of the priority of the Australian workers, we suggest that the name sericine tentatively given to our base be dropped.

We are extremely grateful to Dr. C. C. J. Culvenor of the C.S.I.R.O., Melbourne, for valuable suggestions and supply of an authentic sample of spectabiline. We are also indebted to Dr. K. N. Gaind, Head of the Department of Pharmacy, for keen interest in this work.

Department of Pharmacy,  
Panjab University,  
Chandigarh-3 (Punjab),  
August 6, 1962.

C. K. ATAL.  
M. L. SETHI.

1. Atal, C. K. and Sethi, M. L., *Jour. Pharm. Pharmacol.*, 1961, **13**, 365.
2. Garg, K. N. and Sethi, M. L., *Ind. Jour. Med. Res.*, 1962, **3**, 435.
3. Neal, W. M., Rusoff, L. I. and Ahmann, C. F., *Jour. Amer. Chem. Soc.*, 1935, **57**, 2560.
4. Culvenor, C. C. J. and Smith, L. W., *Austral. Jour. Chem.*, 1957, **4**, 474.

# CHEMICAL INVESTIGATIONS OF LANTANA CAMARA LINN.

*Lantana camara*, growing all over the waste lands throughout the country, is reported to be highly poisonous to live-stock. Lantadenes isolated from the South African species were found to cause photosensitization and severe icterus in animals.<sup>1</sup> Toxic symptoms of lantana poisoning from Indian species of lantana have been reported earlier from this laboratory<sup>2</sup> and the present paper deals with the chemical investigations.

Preliminary chemical examination of the air-dried leaves by successive extraction with various solvents in a soxhlet yielded extractives as follows: Petroleum ether (40-60°), 3.4; ether; 5.1; chloroform 0.8; and alcohol 13.6%. The alcoholic extract indicated the presence of reducing sugars, tannins, resinous substances and colouring matter. Alkaloids and glycosides were found to be absent. Steam distillation of the fresh leaves yielded 0.16% essential oil. Analysis of total ash (8.2%) showed the presence of chloride sulphate, phosphate, iron; calcium, magnesium, sodium and potassium. The acid-insoluble ash was 1.5%. Hot alcoholic extract of the powdered leaves was decolourised and concentrated. It was allowed to cool in a refrigerator and the granules deposited at the bottom of the container were separated and identified as potassium chloride. The filtrate was further concentrated and separated into chloroform soluble and insoluble fractions. Lantadenes were isolated from the chloroform residue.

The chloroform-insoluble fraction obtained above was dissolved in water, treated with lead acetate and basic lead acetate. The filtrate was freed from lead, concentrated to a low volume and precipitated with excess of alcohol. Residue from the decolourised filtrate was taken in boiling methyl alcohol and evaporated to dryness. It yielded an osazone derivative melting at 205° indicating the presence of glucose.

Assay of total lantadenes was carried out by exhausting powdered leaves with alcohol in a soxhlet apparatus. Residue from the decolourised extract was taken in solvent ether and further decolourised. This on evaporation yielded a white amorphous compound representing the total lantadenes. The yield varied from 0.2% during March and April to 1.4-1.7% during the months of July to September depending on the sample collected at different stages of growth.

Processing the plant material for reducing the toxic principles was attempted by preparing

silage according to the usual procedure but under different conditions using pH-4 acetic acid 10% molasses or according to A.I.V. method.<sup>3</sup> The containers were opened after two or three months and the total lantadenes determined after drying the material. Fresh leaves were also subjected to steam heating for 10 hours or continuous boiling with water for the same period. The material was squeezed, dried and assay carried out. Powdered leaves were also treated with water, 20% aqueous KOH, 10% acetic acid, pH-4 hydrochloric acid and sulphuric acid separately. The yield was found to be the same in all these cases indicating that the toxic constituents are highly resistant and the plant material cannot be easily processed into cattle feed.

Our thanks are due to Dr. H. D. Srivastava, Director, for his keen interest in this work.

Division of Animal Nutrition, M. S. SASTRY.  
I.V.R.I., Izatnagar, U.P., V. MAHADEVAN.  
August 28, 1962.

1. Louw, P. G. J., *Onderstepoort, J. Vet. Sci.*, 1948, 23, 233.
2. *Annual Reports of I.V.R.I.*, 1950-51, p. 46.
3. Arthur I. Virtanen, *Cattle Fodder and Human Nutrition*, University Press, Cambridge, 1938, p. 78.

## PRELIMINARY STUDIES ON THE EFFECTS OF GLUTETHIMIDE ON CERTAIN ENZYME SYSTEMS

GLUTETHIMIDE (2-ethyl-2-phenyl glutarimide) is a non-barbiturate hypnotic synthesized by Tagman, Suny and Hoffman (1952). There are many studies indicating the favourable clinical results with this drug.

Rushbrooke *et al.* (1956), during a well-designed clinical trial, found that 0.5 gm. of glutethimide and 0.2 gm. of cyclobarbitone were certainly better than a placebo but did not significantly differ from each other in terms of patient's preference or post-drug drowsiness.

The effect of glutethimide on cellular metabolism and enzymes has been carried out in the present study as the neurophysiological experiments alone do not generally fully explain the mechanism of action of hypnotics.

The effects of the drug on cholinesterase, mono-amine oxidase, glutamic oxaloacetic acid transaminase, glutamic pyruvic transaminase, amino-acid oxidases, and catalase have been studied.

### MATERIAL AND METHODS

The stock solution of the drug was prepared by dissolving it in a dilute solution of sodium

hydroxide and the pH was adjusted to 7.2 by adding dilute hydrochloric acid. The final strength was made up to 10 mgm./ml.

The enzymatic studies were carried out on tissues obtained from freshly killed healthy rats weighing between 120 and 150 gm. The tissue was immediately washed and homogenised in ice-cold phosphate buffer (pH 7.4) in case of experiments with catalase and amine oxidase. Phosphate buffer pH 8.4 in case of amino-acid oxidases and water in case of transaminase and cholinesterase were used. Suspensions of 100 mgm./ml. of tissues were prepared and enzyme activity in control and test experiments, containing graded doses of the drug, determined.

Catalase activity was determined by following the method of Euler and Josephson, as modified by Bonnichsen *et al.* (1947). The enzyme was allowed to act on hydrogen peroxide under specific conditions and the peroxide, remaining after 3 and 6 minutes, determined by iodometric titration.

The activities of glutamic oxaloacetic acid transaminase and glutamic pyruvic transaminase were determined by the method of Cabaud (1956) and Wroblewski (1957) respectively.

Monoamine oxidase activity was measured from the rate of oxygen utilisation by the Warburg apparatus using tyramine as the substrate.

L and D amino-acid oxidase activities were measured from the utilisation of oxygen during the oxidation of L-leucine and DL-alanine, by Warburg technique.

Cholinesterase activity was estimated by Warburg method using acetylcholine as substrate, and measuring the amount of carbon dioxide liberated.

#### RESULTS

It was observed that the drug influenced the catalase activity as shown in Table I.

TABLE I

*Effect of glutethimide on the catalase activity*

(The figures, expressing the unit activity, are the averages of 5 sets of observations in each case)

		Concentration $\mu\text{g./ml.}$				
		2	4	8	16	20
Activity:						
3 minutes	+10 $\pm 0.7^*$	+17 $\pm 1.2$	+32 $\pm 4.2$	+7 $\pm 2.5$	-18 $\pm 1.9$	
6 "	+30 $\pm 2.5$	+42 $\pm 3.1$	+53 $\pm 2.9$	+32 $\pm 4.1$	-44 $\pm 3.7$	

\* Standard deviation.

It will be observed that the drug up to a concentration of 8  $\mu\text{g./ml.}$  increased the catalase

activity but at higher concentrations, the enzyme activity was decreased.

It was also observed that the drug did not affect the transaminases, mono-amine oxidase, L and D amino-acid oxidases and the cholinesterase activities; in concentration up to 100  $\mu\text{g./ml.}$

Department of Pharmacology, B. C. BOSE.

M.G.M. Medical College,

R. VIJAYVARGIYA.

Indore, September 15, 1962.

A. Q. SAIFI.

1. Bonnichsen, R. K., Chance, B. and Theorell, H., *Acta Chem. Scand.*, 1947 **1**, 685.
2. Calaud, F. L. R. and Wroblewski, F., *Amer. J. Clin. Path.* 1956 **26**, 1101.
3. Euler and Josephson, *Ann.*, 1927, **452**, 158.
4. Kushbrook, M., Wilson, E. S. B., Acland, J. D., and Wilson, G. M., *Brit. M. J.*, 1956, **1**, 139.
5. Tagman, Suny and Hoffman, *Helv. Chim. Acta* 1952, **35**, 1514.

#### PLASTICIZERS BASED ON EPOXIDISED C.N.S.L. (CASHEW-NUT-SHELL LIQUID)

CASHEW-NUT-SHELL LIQUID, a phenolic group containing important indigenous raw material of this country, is showing immense potentiality both in the fields of coating compositions and polymers in general. Although a major part of it was exported to U.S.A. up till now, growing interest has been shown lately by the manufacturers and the investigators in this country to find better uses for it.

Out of the two major constituents of C.N.S.L. the phenolic portion contributes to its resin-forming property with methylene donors, and the ethylenic unsaturation plays an important part in the auto-oxidative polymerisation in the presence of driers. The unsaturated  $\text{C}_{15}\text{H}_{27}$  side chain in the meta position bears resemblance to the drying oils except that the double bonds are less reactive; as such this may indicate clearly to its use as a plasticizer. The dark colour of the product due to inherent quinone formation limits its use in this field. By epoxidation under suitable conditions of the double bonds in the side chain products can be obtained which are useful as plasticizer-stabilizer for chlorine containing resins. Work to this effect has been carried out therefore, to etherify or esterify the hydroxyl groups of the material and epoxidise the ethylenic unsaturation present in the side chain. Methylation and acetylation have been accomplished by the use of di-methyl sulphate and acetic anhydride with peracetic acid, and oxirane contents approaching the theoretical value have been



obtained. Products of very pale colour in satisfactory yields have also been obtained. Work is in progress to study the application of this product as a plasticizer for vinyl resins and as a reactive diluent for epoxy resins.

Dept. of Chem. Tech., Y. K. KAMATH.  
University of Bombay, D. B. VIDWANS.  
Bombay-19, December 11, 1962.

#### NOTE ON ENZYMATIC SOFTENING OF WOOD

A METHOD of hardening very soft woods for pencils was worked out in this laboratory.<sup>1</sup> Recently Blankenstein<sup>2</sup> reported a controlled decay process for softening wood for pencil slats. Following this a set of experiments on the action of fungal enzymes on wood was tried and the results are reported in this note.

For these experiments, *Michelia champaca* specimens  $7.5 \times 1.2 \times 0.7$  cm. were used. Cultures of *Poria rhizomorpha* and *Polystictus palustris* were grown on the following medium: Peptone<sub>4</sub>, 1.5 g.;  $\text{KH}_2\text{PO}_4$ , 1.5 g.;  $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ , 0.5 g.; Glucose, 30.0 g.; Becadet, 2/3 tablet; and tap-water 1000 ml.

When the cultures were in vigorous growth the wood specimens were introduced into the flasks. In order to facilitate submersion they were weighted with glass rods. The fungus mats were broken up as far as possible. Toluene was added and the flask kept at 28° C. for 24 weeks. The specimens were then removed, weighed and their elasticity determined.

The results are given in Table I.

TABLE I

Enzyme source	Weight loss %			Modulus of Elasticity loss %	
	Maximum	Minimum	Average	Maximum	Minimum
<i>Poria rhizomorpha</i>	5.2	0	2.6	22.0	+16.3
<i>Polystictus palustris</i>	7.8	0.7	3.1	37.9	+22.6

We are grateful to Dr. Bakshi for the cultures of the fungi.

Forest Research Institute, D. NARAYANAMURTI.  
Dehra Dun, JOSEPH GEORGE.  
August 28, 1962. H. C. PANT.

1. Narayanamurti, D., *et al.*, Ind. Patent No. 52895.
2. Blankenstein, Curt, *Holztechnisches Taschenbuch*, 1956, p. 55.

#### RADIOACTIVITY OF THE SILICEOUS BLACK SHALES AT NAGARJUNA-SAGAR DAM SITE, ANDHRA PRADESH

SILICEOUS black shales exposed at the Nagarjuna-sagar dam site (Sheet No. 56 P/N.W. Lat. 16° 34' 23" N.; Long. 79° 18' 47" E.) have been studied for their radioactivity and content of elements, potassium, uranium, non-carbonate carbon, sulphur and silica, with the object of delineating the nature of the relationship of radioactivity to other constituents.

Stratigraphically the sedimentary rocks exposed at the dam site and in the neighbourhood are believed to correspond to the Srisaï'am stage of the Cuddapah system.<sup>1</sup> They overlie the granites unconformably and consist of massive quartzites, thinly bedded quartzites and shales. A complete section of the rocks exposed at the dam site both on the right and left abutments, the thickness of each of the beds and a description of the shale beds were earlier given by us.<sup>2</sup>

Eleven samples collected from black shale bed on the left abutment have been studied for their beta-activity and potassium contents. The beta-activity of the shales has been determined with a Geiger-Muller counting system, consisting of an electronically-stabilised multi-purpose power unit, a scaling unit and an envelope type G.M. Tube (Type EA-3 B). The potassium content has been determined with a flame photometer (Type KIPP model No. H. 45) by the method of Lillie Jenkins.<sup>3</sup> The values obtained are given in Table I together with the values of uranium, sulphur, non-carbonate carbon and silica, which are cited from our earlier paper.<sup>2</sup>

TABLE I

Sample No.	Beta-activity (counts per minute per gram)	Potassium (K <sub>2</sub> O %) in	U in p.p.m.	Sulphur in %	C in %	Silica in %
1	2.9	3.83	0.13	0.44	0.18	81.23
2	3.7	3.83	0.16	0.63	0.26	73.52
3	3.1	3.00	0.52	0.46	0.44	75.49
4	5.8	5.50	0.22	1.03	0.70	63.77
5	3.1	3.41	0.19	0.57	0.19	79.38
6	3.4	2.58	0.11	0.45	0.37	80.11
7	5.1	5.08	0.45	1.30	0.55	66.83
8	5.2	5.08	0.14	1.02	0.61	86.43
9	2.0	2.58	0.06	0.14	0.07	84.37
10	2.9	3.00	0.10	0.46	0.37	78.09
11	2.4	2.16	0.07	0.36	0.22	80.24

An analysis of the data shows that:

1. The activity bears a fairly direct relationship to the contents of potassium; uranium, sulphur and non-carbonate carbon.

2. The activity has an inverse relationship with the silica content.

3. The ratio between uranium and potassium is not constant.

The beta-activity shown by the shales varies from 3 to 8 times the background count. Considering the fact that the uranium in the shales is very low and the possibility of the presence of thorium being largely precluded by virtue of its geochemical behaviour, the high activity shown by the shales might be principally due to potassium. The absence of regular relationship between uranium and potassium may be ascribed to the absence of sustained reducing environment.

The author is grateful to Dr. U. Aswathanarayana for his kind suggestions. Mr. R. V. Chalapathi Rao has been of great help in the course of field-work. The financial assistance of the Council of Scientific and Industrial Research (India) is thankfully acknowledged.

Geology Department, P. S. N. MURTY.  
Andhra University.  
Waltair, August 28, 1962.

1. Krishna Murthy, T. V. V. G. R., *M.Sc. Thesis* submitted to Andhra University (unpublished), 1950.
2. Murthy, P. S. N., Aswathanarayana, U. and Mahadevan, C., *Econ. Geol.*, 1962, **57** (4).
3. Jenkins, Lillie, *U.S. Geol. Surv. Tech. Rep.*, T.E.I., 1954, **453**, 4.

#### IDAITE, A NEW COPPER SULPHIDE FROM GARIMANIPENTA, NELLORE DIST., ANDHRA PRADESH

GARIMANIPENTA (Topo sheet 57 N/9, longitude 79° 34', latitude 14° 61') was visited by the author in September 1957 and a small collection of copper ores was made from the old workings. The actual specimens described here are from a small pit situated one mile south-east of the Garimanipenta village. The report concerns a new copper sulphide not described earlier from any copper deposit of India.

The following mineralogical and textural features are presented by the ores: (1) Chalcopyrite-bornite-pyrite representing primary mineralization. (2) Malachite-chalcocite hydrated oxides of iron representing the alteration of primary minerals.

The chalcocite is a relict found as irregular grains of varying sizes. The chalcocite and the bornite do not exhibit any interrelationship between themselves but both the minerals are enclosed in chalcopyrite which is younger. Pyrite is the last formed ore mineral, idiomorphic and some of it is recrystallized.

Idaite appears as thin films around the bornite grains, sometimes as fine flakes (micaceous habit) in cracks of the bornite. The colour is reddish-orange and could be distinguished from the red colour of the bornite. It has higher reflectivity compared to bornite but less than the chalcopyrite. The mineral is strongly pleochroic in greens. The anisotropism can be described as enormous. The pleochroism and anisotropism are enhanced when observed under oil immersion.

Covellite has similar intense pleochroism and anisotropism but idaite can be distinguished from its not being blue but green.

Idaite was first discovered and described from Ida mine, South-West Africa by Frenzel (1959). The composition is ascertained as  $\text{Cu}_2\text{FeS}_4$  and it is considered as a secondary mineral formed from bornite at a temperature of 400° C. The present microscopic study suggests that the primary copper deposit (Sen Gupta, 1924) is subjected to metamorphism and a part of the original bornite at 400° C. is transformed to idaite. Subsequent alteration in the zone of oxidation is responsible for the existing large quantities of malachite.

Andhra University, J. S. R. KRISHNA RAO.  
Waltair, August 15, 1962.

1. Frenzel, G., "Idaite und blaubleibender covellin," *N. Jahrb. Min. Abh.*, 1959, **93**, 87.
2. Sen Gupta, "Copper deposits in the neighbourhood of Garimanipenta, Nellore District," *Quart. J. Geol. Min. Met. Soc. India*, 1924, **1**, 157.

#### OCCURRENCE OF RHENIUM IN AN INDIAN COPPER ORE

A SAMPLE of copper ore obtained from the Mosabani Mine, Bihar, had the association chalcopyrite, molybdenite, bornite and quartz. It was subjected to a preliminary chemical examination.<sup>1</sup>

The finely powdered ore was heated with concentrated nitric acid, the solution diluted and filtered. The insoluble residue consisted of quartz. The filtrate was treated with sulphuric acid and evaporated to fumes. The residue was dissolved completely in hydrochloric acid. The solution was warmed and hydrosulphide was passed for several minutes. The solution turned blue and gave finally reddish-brown precipitate. This precipitate was systematically examined for the metals of group II of the qualitative analysis. Molybdenum was identified

in this precipitate by the thiocyanate test.<sup>2</sup> The presence of molybdenum was confirmed directly by dissolving the ore in hydrochloric acid and reducing the ferric iron with zinc and then testing with potassium thiocyanate. A red colour soluble in ether was obtained.<sup>3</sup>

The presence of rhenium was also suspected. This was confirmed by the distillation method in which rhenium was separated and isolated as its volatile chloride.<sup>4</sup> The distillate was tested as follows.<sup>5</sup>

(1) 3 ml. of the distillate were taken into a test-tube and treated with 2 ml. of concentrated hydrochloric acid, 2 ml. of potassium thiocyanate (20%) and 2 ml. of stannous chloride (20%). First a pale pink colour developed which faded away yielding an yellow colouration which is characteristic of rhenium.

(2) To 3 ml. of the distillate, 4 ml. of concentrated sulphuric acid, 2 mg. of  $\alpha$ -benzildioxime, 0.5 ml. of isoamylalcohol and 2 ml. of 15% stannous chloride in 1 : 5 sulphuric acid were added, heated nearly to boiling for 3 minutes and 1 ml. of water was added. Red colour was developed.

Rhenium sulphide is isomorphous with molybdenum sulphide. Noddack and Noddack,<sup>6</sup> and Aminoff<sup>7</sup> have reported on the occurrence of rhenium in molybdenite. It is, therefore, concluded that the rhenium present in the copper ore is directly associated with the molybdenite part of the ore.

The authors express their grateful thanks to Prof. K. Neelakantam and to Prof. M. G. Chakrapani Naidu for their kind interest in the work.

Depts. of Chemistry      N. APPALA RAJU.  
and Geology,              R. JAGADISWARA RAO.  
S. V. University College, P. UMATHY.  
Tirupati, August 25, 1962.

1. Scott, W. W. and Furman, N. H., *Standard Methods of Chemical Analysis*, 1939, 1, 369.
2. Vogel, A. I., *A Text-Book of Macro and Semimicro Qualitative Inorganic Analysis*, 1954, p. 591.
3. Schoeller, W. R. and Powell, A. R., *A Text-Book of the Analysis of Minerals and Ores of the Rarer Elements*, 1940, p. 200.
4. —, *Ibid.*, 1940, p. 239.
5. Snell, F. D. and Snell, C. T., *Colorimetric Methods of Analysis*, 1954, 2, 541.
6. Noddack, I. and Noddack, W., *Z. Physic. Chem.*, 1931, 154 A, 207.
7. Aminoff, G., *Geol. Fören. Stockholm Förh.*, 1943, 65, 71.

## GLOSSOPTERIS FRUCTIFICATIONS FROM CHINTALPUDI SANDSTONE, SOUTH INDIA\*

SINCE the first announcement of fructifications attached to *Glossopteris* leaves from Transvaal, South Africa in Middle Ecca (L. Permian) beds, in 1952 by Plumstead<sup>1</sup> and her subsequent contributions,<sup>2-4</sup> much careful search is being made for these organs by the palaeobotanists working on the Gondwana flora. A careful search in this direction by Pant<sup>5</sup> and Thomas<sup>6</sup> has already resulted in some new types of fructifications from Africa ascribed to *Glossopteris*. Probable male organs and fructifications of *Glossopteris* have also been reported from India by Sen<sup>7-10</sup> and from Australia (personal communications from Plumstead and Sen) by Rigby.<sup>11</sup>

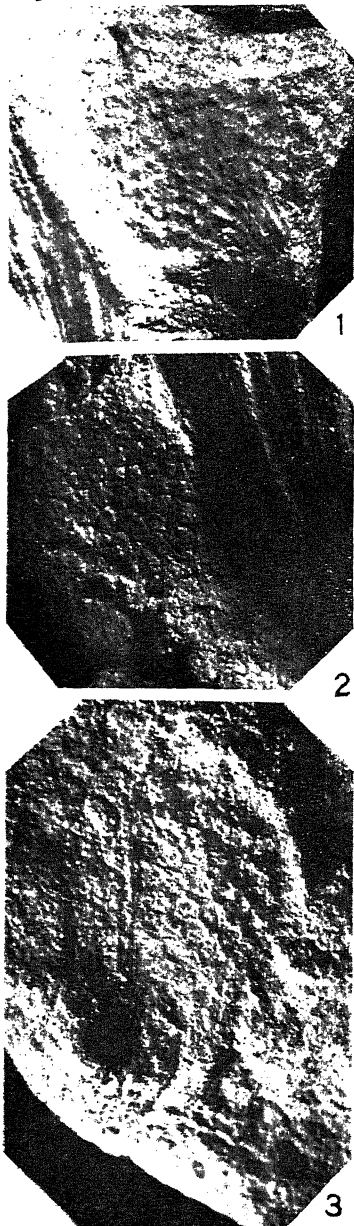
The present discovery of the two genera of fructifications from the Chintalpudi Sandstone formation is not the result of a systematic search for such organs but an accidental find by a field party of the Commission<sup>12</sup> working in the West Godavari District during 1960-61. Earlier from India, Sen<sup>7-9</sup> described some male fructifications referable to *Glossopteris* and also described a *Glossopteris* bearing sori-like structures which are different from those described by Feistmantel.<sup>12-13</sup> Sen<sup>10</sup> also described two fructifications which resemble very much Plumstead's genus *Lanceolatus* from Murulidih Collieries of the Raniganj stage (Upper Permian). Apart from this Plumstead's other genera *Scutum* and *Hirsutum* were not known from India. The present note illustrates and describes two fructifications resembling those of *S. leslium* and *H. dutoitides*, recovered from India for the first time. The various species of *Glossopteris* leaves recognised in the present collection are *G. browniana*, *G. retifera*, *G. indica*, *G. decipiens* and *G. communis*.

*Fructification Type-1*.—The detached fruit is preserved on the sandstone as an impression having no organic matter, the two counterparts are illustrated (Figs. 1 and 2). The cupule is rounded, about 1.7 cm. in diameter, with fluted margins about 2.5 mm. long (partially preserved) all round the main head and about 2 mm. wide. A small pedicel is preserved which is 4 mm. wide at the point of attachment with the cupule

\* Read at the 14th Annual Scientific Meeting of the Palaeobotanical Society of India, Lucknow, with the permission of the Director of Geology. The views expressed here are entirely those of the author.

\*\* Dr. S. Ramanathan, Mr. V. L. Narsimham and Mr. P. V. L. Babu.

and narrowing towards the lower end (in the present specimen) to about 3-3.5 mm. The



FIGS. 1-3. FIG. 1. Fructification Type-1. Impression of a rounded ovuliferous cupule with fluted margins (seen better on the left half of the specimen) and a striated, partly preserved stalk,  $\times 2$ . FIG. 2. Fructification Type-1. Impression of a partly and illpreserved counterpart (mould) of the above, showing pentagonal to hexagonal sac outlines with a central depression in each,  $\times 2$ . FIG. 3. Fructification Type-2. Impression of an oblong cupule with sac outlines and stout stalk. Fluted margins are preserved on the right side (seen as white border on the upper half of the cupule),  $\times 2$ .

pedicel is strongly striated, the striations extend into the ovuliferous area, specially well observed in the lower part. In the preserved part of the pedicel three striations are very clearly seen and are separated from each other by about 1.5 mm. Calculations indicate that the present specimen must have possessed 6-8 such raised structures over the pedicel. The fertile part is rounded, about 12.5 mm. in diameter, studded with impressions of sacs which seem to have been closely appressed with each other presenting an overall aspect of pentagonal to hexagonal (at places irregularly angular sacs are also observed) snapped impressions with an average diameter of about 1.5 mm. In the centre of each of these (Fig. 2) are clearly seen fine circular depressed areas representing the place of attachment of the stigma or base of style according to Plumstead's interpretation" (p. 14). As would be seen from the foregoing description the specimen shows a close resemblance with *Scutum leslium* Plumstead, in shape and size of the stalk, cupule, cupule margin and the impressions left over by the ovules and the central cores except for the partial preservation of the wing.

*Fructification Type-2.*—This specimen (Fig. 3) representing the fertile half is also preserved as an impression on a coarse sandstone, on an uneven surface. The pedicel appears to be probably coming out of the petiolar part of a leaf, which is partly preserved and the venation of which is not clear for a specific identification.

The cupule is oblong with a rounded apex and a rounded base which is definitely not flattened. The supporting pedicel is not attached exactly in the centre but is slightly shifted towards one side and is bent (not straight) sideways. Even in the fossil state the cupule and the stalk are not preserved in the horizontal level of the matrix, hinting indirectly that the stalk must have been a stiff organ subtending the cupule upwards with reference to the flat lying leaf even at the time of deposition and fossilization. The observed length of the pedicel is 1 cm. (the actual length is not seen in the photograph because it is not preserved at the same level) and about 3 mm. broad (diameter). Due to weathering the longitudinally running striations are not clear on the pedicel, but their extension into the ovuliferous part of the cupule is seen in the specimen. Woody nature of the pedicel of this species is clear from the mode of preservation.

Total length of the oblong cupule is about 1.9 cm. The maximum width near the basal

part measures about 13.5 mm. The fluted margin is clearly observed on one side only due to bad preservation. Fluted structures are 2 mm. long and 1.5 mm. broad, and gradually widen outwards. The fertile part consists of impressions of sacs which must have been closely appressed with each other, some are apparently circular but on careful observation the pentagonal and hexagonal outlines are discernible. Each of these are about 1.5 mm. in diameter and in most of them central protuberances are seen. The Indian specimen shows a good resemblance in many features with *H. (Scutum dutoitides) Plumstead dutoitides* Plumstead but due to the bad preservation of the fertile half and the absence of the sterile half with hair-like markings a detailed comparison could not be made. The discovery of better preserved specimens in future would indicate if it is related to *H. dutoitides* or represents some other species.

The author is indebted to Mrs. E. Plumstead and Dr. J. Sen, for the literature and information supplied. He is also thankful to Messrs. A. K. Ghosh, L. P. Mathur, M. C. Poddar and Dr. K. R. Surange for the facilities provided for this work.

Oil and Natural Gas Commission. C. P. VARMA.  
Dehra Dun (India), July 11, 1962.

1. Plumstead, E. P., *Trans. Geol. Soc. S. Africa*, 1952, **55**, 281.
2. —, *Ibid.*, 1956, **59**, 211.
3. —, *Palaeontographica*, 1956, **100**, Bd. abt. B, 1.
4. —, *Trans. Geol. Soc. S. Africa*, 1958, **61**, 51.
5. Pant, D. D., *Bull. Brit. Mus. (N.H.), Geology*, 1958, **3** (4).
6. Thomas, H. H., *Ibid.*, 1958, **3** (5).
7. Sen, J., *Nature*, 1955, **176**, 742.
8. —, *Proc. Nat. Inst. Sci. India*, 1955, **21 B** (1), 48.
9. —, *Nature*, 1956, **177**, 337.
10. —, *B.t. Nostr.*, 1955, **108**, 251.
11. Rigby, J. F., *Aust. Journ. Sci.*, 1961, **23** (7), 230.
12. Feistmantel, O., *Pal. Ind. Ser.* 12, 1881, **3** (1), (Supplement).
13. —, *Ibid.*, 1866, **4** (2).

## TECTONIC FEATURES OF THE AREA AROUND PINJOUR

WHILE investigating the stratigraphy, palaeontology and structure of the Upper Shivaliks west of the Sirsa-Jhajra drainage (toposheet No. 53 B/13), the area further east where the Lower Shivaliks are exposed was also examined. The present note thus deals broadly

with the main structural features of the region between Kalka and Chandigarh (see Fig. 1).

### LOWER SHIVALIKS

Several traverses were taken to obtain a general idea of the geology of the Lower Shivaliks of this region which will be dealt with in greater detail later. It is well known that the main boundary fault separates the Lower Shivaliks from the overlying beds (Subathus) and is marked at places by breccia. The main evidence for the thrust is, however, tectonic because we find that the Lower Shivalik sequence, somewhere folded, elsewhere consisting of regular N.E. dipping beds plunges below the Subathu-Dagshai-Kasauli sequence with a different strike. This truncation of the Lower Shivalik beds below the Subathus is easily observed. Moreover, in our opinion, it is not the Nahans that form the thrust contact but a series of reddish, nodular shales with thin interbedded sandstones, probably belonging to the Chinji stage (Pilgrim, 1913, p. 268). This opinion is based on lithological similarity for no fossils characteristic of the Chinjis have so far been found. We must also not lose sight of the alternative that these beds may represent the Nurpur series (transitional between Chinji and Nagri or equivalents of the Nagri), unless it can be shown that *Hipparion* occurs in great profusion, of which there is no evidence so far. On the whole, the assignation of these beds to the Nahans seems exceedingly doubtful except perhaps in the case of the lowermost sandstone. South-west of the main boundary fault there is a broad belt of purplish and reddish shales whose south-western boundary is again a faulted one, the contact rock being the Lower Boulder Conglomerate. This fault is designated the Pinjaur fault.

Judging by sections in the Koshallia Nadi, the above belt can be further divided into a north-eastern and a south-western unit which abut against one another at the axis of an anticline. Though a fault cannot be seen, the possibility of one occurring at the anticlinal axis cannot be overlooked since percolation of water and smaller faults at the axis are not uncommon wherever exposures are clearly seen. The north-eastern unit begins from Batinan village (30° 48' 50" : 76° 56' 30") in the south and extends up to the main boundary fault in the north. The amount of dip gradually increases northward from 34° to 78°. The purplish shale is conspicuous by its absence in this unit while in the south-western unit the purplish shales predominate. The latter unit extends from Batinan

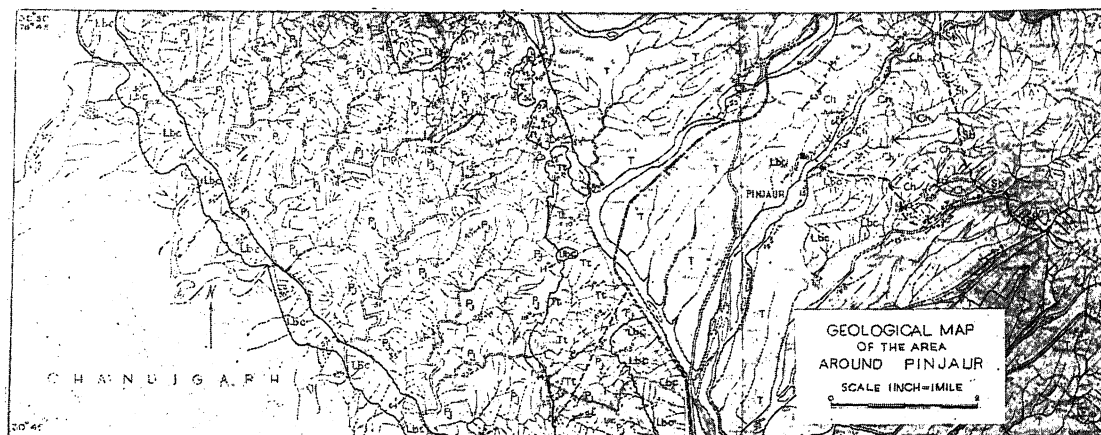
village to the Pinjaur fault in the south, the beds being well folded with high dips, reaching  $80^\circ$  at places. Ten anticlines and nine synclines have been observed and there may be others buried below the covering debris. At a distance of two miles south-east of the Koshallia Nadi exposure, there are only two broad anticlines and two synclines in this unit, while the entire north-eastern unit dips uniformly in a north-east direction. In the Koshallia Nadi exposure, the purplish shales predominate while here it is the lower sandstone which dominates over the shales.

and Basawal, but there is no overt evidence of this; so, on the whole, a fault appears to fit better into the picture.

It is interesting to observe that only a small stretch of ground separates the Sirsa drainage from that of the Jhajra. The shortest distance between the drainages is situated near Basawal, the two being hardly a furlong apart.

#### UPPER SHIVALIKS

South-west of the Pinjaur "Dun" the Tatrot, Pinjaur and Lower Boulder Conglomerate stages are involved in an anticlinorium in which fold-



T, River Terraces; Ubc, Up. Boulder Conglomerate; Lbc, Lr. Boulder Conglomerate

Pj, Pinjaur; Tt, Tatrot; Ch, Chinji; Sb, Subathu; ---, Fault.

FIG. 1.

We suspect that the Pinjaur fault (between the Lower and Upper Shivaliks) should be traceable further north-west possibly up to Nalagarh and beyond. At the same time, the drainage pattern and high dips in the Upper Shivaliks adjacent to the "Dun" valley near Dhamala and north-westward are suggestive of a major fault running NNW-SSE, meeting the Surajpur fault near the Surajpur Cement Factory. Thus the "Dun" (valley) separating the Upper Shivaliks from the Chinjis constitutes a graben. This feature can be seen clearly from the higher ground, e.g., around Kasauli. It would appear that the Sirsa Nadi follows the line of a major fault. It is also postulated that the Sirsa and Jhajra were at one time connected but the drainage direction which was NNW (discharging into the Sutlej) was partially altered due to faulting (probably continuation of the Surajpur fault which, however, cannot be followed beneath the river terraces). As a result, the Jhajra took its present SSE direction. Another possibility which could have changed the drainage pattern is uplift between Kalka

ing becomes progressively more severe from west to east. The Lower Boulder Conglomerates fringing the alluvial plain dip south-west at varying angles, the amount increasing south-eastward, the maximum dip being approximately  $80^\circ$ . The underlying Pinjaurs constitute a wide belt conformable with the Lower Boulder Conglomerates, and form the western limb of the anticlinorium in the subsidiary folds of which the Tatrots are exposed.

Two such well-defined anticlines can be followed striking approximately N-S, and are separated by an intervening syncline which appears to be faulted. The syncline disappears nearabout Tanda, being dominated by the main fold. The eastern boundary of the rocks exposed here forms a sharp but discontinuous syncline.

It is also noteworthy, that the Tatrot outcrop is not continuous; also northwards it forms two distinct domes along the axis of folding, separated by very narrow outcrops of the Pinjaurs.

The main anticline plunging SSE is broken up by a major fault (which we propose to call the Surajpur fault) between Surajpur Cement

Works and Khol Tandu. This fault strikes approximately NNE-SSW and fades slightly westward. It may be described as a hinge fault. Half a mile south of Khol Tandu, the main fold reappears for a short distance and then becomes covered by the Ghaggar terraces ( $T_1-T_3$ ). The Pinjaura are here exposed in the streams which have cut deeply through the terraces. Their anticlinal structure can be determined from the dips observable in the stream cutting.

Geology Department, M. R. SAHNI.  
Panjab University, EHSANULLAH KHAN.  
Chandigarh, December 23, 1962.

### CHROMOGRAPHIC CONTACT PRINTS FOR GOLD

A DETAILED investigation of the gold mineralisation in the Kolar Gold Deposits has been taken up by the senior author (A. N. R.) some years back, and systematic field-work was carried out by him at Nundydroog Mines. During the examination of the polished sections, the identification of minute specks of gold was sometimes difficult under the microscope, and therefore a determinative method of identification without affecting the section was sought by the authors.

Etch and microchemical tests are known for gold using certain organic and inorganic reagents including pyridine in hydrobromic acid, which produces deep-brown to golden-yellow crystals of pyridine-gold double bromide.<sup>1</sup> However, these tests are disadvantageous for applying on polished sections, as they will spoil the specimen besides limiting the area of testing to a very small part of the specimen. Consequently, an attempt has been made to see if the same reaction could be used to obtain chromographic contact prints for gold following the technique described by Williams and Nakhla.<sup>2</sup>

A gelatine-coated paper strip is impregnated with aqua-regia (attacking reagent) and the gelatine side is pressed against the polished surface of the section maintaining contact for 20 to 30 seconds using a hand press. The paper is then peeled off and 'developed' in the specific reagent, pyridine in excess HBr (1 vol. pyridine and 8 vols. HBr 46%). Cherry-red spots develop almost immediately indicating gold. Ordinary photographic paper freed from silver salts (by washing in hypo and then in water) serves the purpose well.

Contact prints for gold in association with other minerals like arsenopyrite, pyrrhotite; etc., also have been successful indicating that the reaction is not influenced adversely by interference of other associated elements.

The cherry-red colour of the print is fairly stable at atmospheric temperature conditions. The colour also appears to be unaffected by the atmospheric humidity, although the compound is water soluble.

The contact print technique thus appears to be superior to microchemical testing for gold particularly in polished sections.

The authors are thankful to Dr. C. Bhimasankara Rao of Chemistry Department for his help in the work.

Dept. of Geology, A. NARASINGA RAO.  
Andhra University, T. V. S. R. KSHIRA SAGAR.  
Waltair, September 7, 1962.

1. Putnam, P. C., Roberts, E. J. and Selchow, D. H., *Am. Jour. Sci.*, 1928 (5th series), **15**, 455.
2. David Williams and Nakhla, F. M., *Trans. Inst. Min. Met.*, 1951, **60**, 257.

### SELECTIVE DIGESTION IN THE MAJOR CARPS OF INDIA

THE major carps of India are freshwater fishes of great commercial importance. Earlier observations on their food and feeding habits have determined the qualitative and quantitative composition of food and limits of their feeding zonation.<sup>1-6</sup> There has been no previous account on the selective digestion of any of the major carps excepting some reference made on their fry.<sup>1</sup> During the course of the investigation on the food of major carps namely *Labeo rohita* Ham., *Catla catla* Ham., *Labeo calbasu* Ham. and *Cirrhina mrigala* Ham., besides analysing the contents of guts, a close observation on the state of digestion of the various organisms was also made. For this study, 45-50 specimens of each species measuring 300 mm. or more in total length were collected from a few fish tanks in Delhi. The food present in the intestinal bulb was washed out and preserved in 10% formalin solution. A portion of the posterior-most region of the hind-gut was also taken out, opened and preserved. Each food organism was examined under a binocular microscope, listed and its state of digestion in the gut closely observed.

*L. rohita* was found to feed on a variety of organisms. Green and blue-green algæ, phyto-flagellates, diatoms, rotifers and crustaceans formed its main food. Of these, the algal food was most dominant in this species. *C. catla* mainly consumed large quantities of crustaceans and rotifers. In this fish, the intake of algal food was far less in quantity. *L. calbasu* and *C. mrigala* ingested large quantities of mud, sand and fragments of decaying plants in addition

to the usual plankton organisms. Although the food composition of the four fishes differed to a certain extent, yet the various food constituents were essentially the same, as they came from the same environment. All these species, though plankton feeders, seem to have an unrestricted choice of food which points to an omnivorous habit with certain amount of indiscriminate grazing. The intake of large food organisms, however, whether animals or plants, involved a deliberate effort of catching on the part of the fish whereas small organisms which were in far greater abundance were probably ingested passively along with larger food organisms.

In all the four major carps under investigation, zooplankton organisms whenever ingested were found to be completely digested. In the hind-gut their remains were seen as carapace, appendages, lorica, etc. Diatoms were found in the faeces as empty shells or as broken fragments. The rest of the algal food was subjected to varying degrees of digestion. Green algae like *Oedogonium*, *Spirogyra* and *Cosmarium* were fully digested. Their cell remains appeared in the hind-gut without any green pigments. Many of the smaller forms, on the other hand, such as *Chlamydomonas*, *Tetraspora*, *Cœlastrum*, *Ankistrodesmus*, *Dictyosphaerium*, *Kirchneriella*, *Oocystis*, *Quadrigula*, *Tetraedon* and *Scenedesmus* remained more or less unchanged in the alimentary canal and passed out undigested. The blue-green algae which were occasionally ingested in appreciable quantities were subjected to little or no change by the action of various digestive enzymes, the only exception was that of *Microcystis* colonies which were broken into smaller bits but the individual cells were still recognisable. The various undigested blue-green algae recorded from the faeces of the major carps were *Merismopedia*, *Synechocystis*, *Oscillatoria*, *Spirulina*, *Nostoc* and *Anabaena*. The other undigested forms noted were *Euglena*, *Phacus* and *Trachelomonas* of the Euglenophyceae. These were frequently present in the faecal matter with apparently no change in their form and structure.

It therefore seems that all food items ingested by the fishes are not of equal importance. It was surprising to find that among the green algae, larger filamentous forms like *Oedogonium* and *Spirogyra* were fully digested by the fishes whereas some of the smaller forms such as *Scenedesmus* and *Kirchneriella* were not subjected to any digestive action. Probably the ability of the fish to digest some algae and not

others largely depends upon the nature of algal cell-wall. Algae which have a resistant, continuous cell-wall or a covering sheath of mucilage seem difficult or impossible to digest. The fact that diatoms are digested even though they possess a firm siliceous cell-wall is because of their having at places thin points called striae or punctae. The digestive enzymes could easily penetrate through these points and act upon the cell contents.

Since many of the algae pass through the alimentary canal undigested, it is quite likely that these may be appearing again in the standing crop of plankton. The diatoms are utilised by the fishes and hence there is no possibility of the very same forms appearing again in water. This explains the author's observation<sup>7</sup> of a poor diatom population in some of the fish tanks in Delhi. However, a culture of the algae from the faeces of carps, as has been done in *Tilapia mossambica*,<sup>8</sup> seems an important study to elucidate the problem further.

I wish to thank Dr. M. Chandy and Dr. S. Z. Qasim for their valuable help. My thanks are also due to the Council of Scientific and Industrial Research, India, for the award of a Senior Research Fellowship.

Department of Zoology,

M. G. GEORGE.\*

Aligarh Muslim University,

Aligarh, U.P., August 7, 1962.

Present address : Central Public Health Engineering Research Institute, Nagpur.

1. Mookerjee, H. K., *Sci. and Cult.*, 1944, **9**, 306.
2. —, Sen Gupta and Roy Choudhury, P. K., *Ibid.*, 1946, **12**, 247.
3. Chacko, P. I. and Kuriyan, G. K., *Proc. zool. Soc. Lond.*, 1950-51, **39**, 120.
4. Alikunhi, K. H., *J. zool. Soc. India*, 1952, **4**, 77.
5. Das, S. M. and Moitra, S. K., *Proc. nat. Acad. Sci., India*, 1955, **25 B**, 1.
6. Vasisht, H. S., *Res. Bull. Punjab Univ.*, 1959, **10**, 65.
7. George, M. G., *Ph.D. Thesis*, Delhi University, 1961.
8. Vas. F. H. and Hofstede, A. E., *Contr. Ind. Fish. Res. St. Bogor.*, 1952, **1**, 1.

#### A RARE FISH, *VELIFER AFRICANUS* SMITH, FROM THE BAY OF BENGAL

In the course of exploratory fishing off the Andhra and Orissa coasts during the last three years, the vessels 'Ashok' and 'Pratap' of the Government of India Off-Shore Fishing Station, Visakhapatnam, have been doing intensive trawling at different depths along the continental shelf.

During one of the cruises in 1960, a single specimen of a rare and interesting fish; *Velifer africanus* Smith (Family: Veliferidae, Smith



1951, 1953, 1961), was obtained at a depth of about 50 fathoms off the north Andhra coast. The exact date, location and depth of haul are unfortunately not available. Previously, *V. africanus* was recorded only from Mozambique Channel, between Mozambique and Malagasy in the Arabian Sea.

The salient characters of the fish are given below:

*Velifer africanus* Smith

Linear measurements (in cm.):

T.1	St.1	Ht.*	Hd.	Sn.	Eye
16.20	13.10	6.40	3.90	1.10	1.05

\* Height (= depth) of body excluding scaly sheath at base of dorsal and anal fins.

Meristic data:

D.	A.	P.	V.
34	24	14	8

A small, hidden spine can be felt in front of the anal fin. Colour silvery grey, with eight distinct dark grey transverse bands, first band passing through eye, last band at base of caudal fin; an incomplete band dorso-laterally in front of eye. Dorsal, anal and ventral fins dark grey, caudal light grey. Scales small, deciduous. Well-developed scale-covered sheath covers base of dorsal and anal fins. Ventrals extend to 6th anal ray. Caudal forked. Longest dorsal ray (3rd) is longer than greatest depth. Mouth protrusible downward (as in *Gerridae*).

The author expresses his thanks to Sri. A. T. Sheriff, Deputy Director, Off-Shore Fishing Station, Government of India, Tuticorin (then at Visakhapatnam), who kindly presented the specimen to the Department of Zoology, Andhra University, and to Prof. P. N. Ganapati for facilities.

Department of Zoology,  
Andhra University,  
Waltair, August 20, 1962.

S. DUTT.

1. Smith, J. L. B., *Ann. Mag. Nat. Hist.*, 1951, 4 (12).
2. —, *Mem. Mus. Dr. A. de Castro*, 1958 (2).
3. —, *The Sea Fish, South Africa*, 4th Ed., 1961.

AN OBSERVATION ON THE  
ANTAGONISTIC EFFECT OF  
*B. SUBTILIS* ON *AZOTOBACTER*  
*VINELANDII* LIPMAN

WHILE studying the total bacterial population in a green manuring experiment, a zone of lysis was observed around the colony of a bacterium. The organism, showing antagonistic effect, was later identified as *Bacillus subtilis* Cohn, emend Prazmowski in the microbiological laboratory of the Indian Institute of Science; Bangalore. This

organism has been recorded to exercise antagonistic effect on several Gram-positive and Gram-negative bacteria and also fungi.<sup>1-8</sup> We wanted to see whether the isolated bacterium has any effect on *Azotobacter vinelandii* Lipman a non-symbiotic nitrogen-fixing soil organism. The cultures were maintained on beef extract peptone agar slants. The culture filtrate was obtained in the broth after three days incubation at 37° C. Its effect was studied by the cup-assay and the cross-streak methods. In the cup-assay the 2-day old culture filtrate of *B. subtilis* showed an average inhibition of 19 mm. and the 3-day old filtrate 20 mm. inhibition. The nature of the antibiotic spectrum of the culture filtrate of the bacterium is being studied.

Agricultural Chemistry and D. P. JOHARI.  
Soil Science Section, AMBIKA SINGH.  
Indian Institute of Sugarcane  
Research, Lucknow, August 30, 1962.

1. Cercós, Augusto, P., *Rev. Invest. Agric.*, 1950, 4, 3.
2. Hassall, C. H., *Nature*, London, 1948, 317.
3. Hobby, G. L., Tulita, F., Lenert and Nancy Dougherty, *Ann. New York Acad. Sci.*, 1949, 52, 775.
4. Jensen, E. F. and Hirschman, D. J., *Arch. Biochem.*, 1944, 4, 297.
5. Landy, Maurice, Samford, B., Roseman and George H. Warren, *J. Bact.*, 1947, 54, 24.
6. Newton, G. G. F., *British J. Expt. Path.*, 1949, 30, 306.
7. Pratt, R. and Dufrenoy, J., *Antibiotics*, J. B. Lippricoll Co., London, 1953.
8. Vasudev, R. S., Subbiah, T. V., Sastry, M. L. N., Rangaswamy, G. and Iyengar, M. R. S., *Ann. Appl. Biol.*, 1958, 46, 336.

ROLE OF ENZYMES IN RED ROT  
DISEASE OF SUGARCANE

THE conidial stage *Colletotrichum falcatum* Went of *Golmerella tucumanensis* (Speg.) Arx and Muller has a worldwide distribution. It is of special importance in tropics and subtropics where it causes red rot of sugarcane. In India special significance has been attached to this disease because of its severity on the standing canes. Considerable amount of work has been done on the morphology of the fungus and breeding of varieties resistant to the disease. However, little attempt has been made to study the physiology of host parasite interaction. Rapid disintegration and rotting of tissues within the internodes of sugarcane<sup>1</sup> suggested the possibility of enzymatic action in the pathogenesis. On the basis of maceration of potato discs it has been reported that mycelial extract of the fungus contains a pectinase.<sup>2</sup> The present paper describes preliminary studies

regarding production of extracellular pectolytic and cellulolytic enzymes by *Colletotrichum falcatum* Went and their possible role in disease development.

Modified Richard's solution containing different carbon sources and 0.01% yeast extract was used to culture the fungus. A highly pathogenic isolate of the fungus isolated from diseased sugarcane (B. 29) was used for the purpose. Various carbon sources employed in this study were 3% sucrose, 1% citrus pectin (Sunkist Growers, California), 1% carboxy methyl cellulose (C.M.C. 30, Hercules Powder Co.) and 1% filter-paper pulp. Culture filtrates for enzyme estimation were prepared from still cultures of the fungus grown for 6 to 7 days at room temperature (28–30° C.) in 250 ml. Erlenmeyer flasks containing 50 ml. of liquid medium. The medium was then freed of the mycelium and spores by filtering through Buchner funnel and sintered glass filter respectively. The filtrate thus obtained was used as the enzyme sample.

Pectin methyl esterase (P.M.E.) activity was determined by the continuous titration method of Kertesz<sup>2</sup> using 1% pectin containing 0.1 M NaCl as a substrate at pH 7.5. Polygalacturonase (P.G.) and cellulase (Cx) were measured by estimating the loss of viscosity of substrates in Ostwald viscometers. The substrates for the assay of P.G. and Cx were 1.2% sodium polypectate and 1.2% carboxy methyl cellulose (C.M.C. 70 Hercules Powder Co.) respectively, each containing citric acid-sodium hydroxide buffer at pH 5.5.

The culture filtrates from sucrose-containing media showed very weak P.M.E. activity as compared to those containing 1% citrus pectin (Table I).

Polygalacturonase (P.G.) activity was observed in all the culture filtrates obtained from both the sucrose and pectin-containing media. However, considerably more enzyme was produced in pectin-containing media in comparison to sucrose. The filtrate caused a rapid loss of viscosity of sodium polypectate solution (Fig. 1).

Culture filtrates from sucrose-containing media showed a very weak cellulase (Cx) activity but significantly more enzyme was produced when C.M.C. or filter-paper pulp was used as carbon source. Filter-paper pulp was found to be the best substrate for enzyme production (Fig. 2).

These results indicate that the red rot organism, *C. falcatum*, produces both pectolytic enzymes as well as cellulase in culture and both of these enzymes seem to be adaptive in nature (Table I),

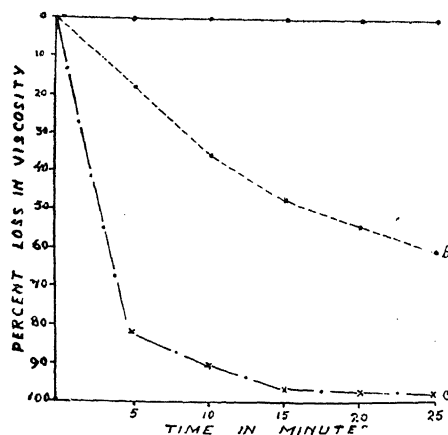


FIG. 1. Rate of loss in viscosity of 1.2 % Sodium polypectate caused by (a) heated culture filtrates, (b) nonheated culture filtrate containing sucrose, (c) nonheated culture filtrate containing pectin.

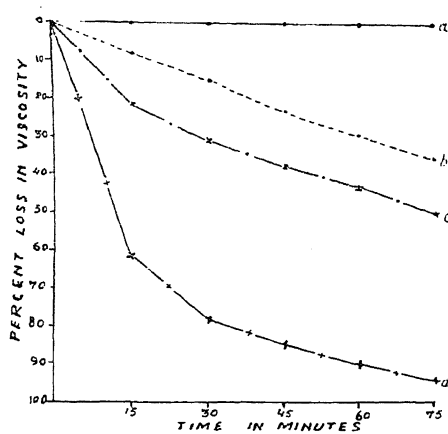


FIG. 2. Rate of loss in viscosity of 1.2 % Carboxy-methylcellulose caused by (a) heated culture filtrates, (b) nonheated culture filtrate containing sucrose, (c) culture filtrate containing C.M.C., (d) nonheated culture filtrate containing filter-paper pulp.

TABLE I  
Effect of carbon source on enzyme activity

Carbon source	Enzyme activity		
	Cellulase*	P.G.*	P.M.E.†
Sucrose	.. 9	57	0.372
Pectin	.. ..	400	1.24
CMC	.. 13	..	..
Filter paper pulp	.. 95	..	..

\* Enzyme activity expressed as reciprocal of time for 50% loss in viscosity of the substrate,  $\times 1000$ .

† Enzyme activity expressed as milliequivalent of methoxyl groups freed by one ml. of enzyme in 30 minutes.

Since breakdown of host tissues is an important process in the development of red rot, it is logical to assume that these hydrolytic enzymes play an important role in the disease syndrome. The production of these enzymes is probably responsible for disintegration of the tissues of affected plants. These enzymes may also help the organism in invasion of the host tissue.

Our grateful thanks are due to Dr. Babu Singh, Principal and Dr. H. K. Saxena, Professor of Plant Pathology, for their keen interest and help in this investigation.

Govt. Agricultural College, Kanpur,  
Regional Research Centre,  
(Oilseeds and Millets),  
I.C.A.R., Kanpur, July 21, 1962.

G. P. SINGH.  
AKHTAR HUSAIN.

1. Edgerton, C. W., *Sugarcane and Its Disease*, Louisiana State University Studies Biological Series, No. 3, 1955.
2. Kertesz, Z. I., *The Pectic Substances*, Interscience Publishers, New York, 1951, p. 628.
3. Ramakrishnan, T. S., *Proc. Ind. Acad. Sci.*, 1941, 14 B, 395.

#### A PRELIMINARY REPORT ON NUCLEIC ACID LEVELS IN MINERAL DEFICIENT PLANTS

In the present investigation, an attempt has been made to study the effect of mineral deficiencies on the nucleic acid level in various parts of *Linum usitatissimum*.

The linseed plant (*Linum usitatissimum*) var. NP (RR) 5 was selected for the investigation. Plants were grown in acid-washed sand supplied with Arnon and Hoagland (1940) culture solution in enamel pots. Phosphorus and potassium deficiencies were created by substituting equivalent amounts of ammonium chloride for ammonium dihydrogen phosphate and sodium nitrate for potassium nitrate respectively. The

deficiency effects of phosphorus and potassium were marked in general by stunted plant growth and a marked reduction in the leaf area of deficient plants as compared to control. The ribonucleic acid (RNA) was extracted by cold and hot perchloric acid method as suggested by Ogur and Rosen (1950). After the extraction of RNA, the remaining residue was treated with 0.5 N perchloric acid for 20 minutes at 70° C. and centrifuged. Most of the DNA comes into solution which is decanted after centrifugation and the residue re-extracted by 2 N-HCl, the two aliquots were combined and estimated for DNA. The RNA and DNA were then estimated spectrophotometrically by noting the optical density at 260  $\mu$ . However, the quantitative values for RNA were obtained by plotting the optical density and extrapolating the values from a predetermined calibration curve obtained for synthetic RNA (NBCO) preparation. The analyses were made at the first and second harvest and were compared with control sets of the same age. Root, shoot and leaves were separately analysed.

The results obtained are summarised in Table I. It will be seen that with advancing age, i.e., at the second harvest, increase in RNA content was noticed in root, shoot and leaf of both control and deficient plants. However, a decrease DNA content was noticed in case of root of control and P-deficient plants but increase in case of K-deficient plants. Moreover, in leaves of K-deficient plants only a slight decrease was noticed. Shoot recorded an increase in all cases.

An examination of Table I discloses that at the first harvest P-deficiency resulted in a marked decrease in the RNA content of root, shoot and leaf. But reverse was true with K-deficiency. At the second harvest, the root and shoot recorded higher values for control as against both P- and K-deficient plants but the leaf did not show any change in the RNA content.

TABLE I

*Distribution of Nucleic Acids in different parts of Linum usitatissimum as affected by phosphorus and potassium deficiencies*

Treatments	RNA (Mg./gm. F. wt.)						DNA (Optical density/gm. F. wt.)					
	First Harvest			Second Harvest			First Harvest			Second Harvest		
	Root	Shoot	Leaf	Root	Shoot	Leaf	Root	Shoot	Leaf	Root	Shoot	Leaf
Control	0.300	0.240	0.820	1.250	5.640	2.920	0.130	0.185	0.440	0.046	0.412	0.700
-P	0.080	0.140	0.500	0.310	1.920	2.920	0.115	0.160	0.370	0.010	0.280	0.420
-K	0.340	0.320	1.050	0.350	5.200	2.920	0.150	0.360	0.620	0.230	0.960	0.490

N.B.—Data are averages of two closely duplicate experiments.

The values for P-deficient plants were always the lowest at the first and the second harvest except in case of leaves at the second harvest.

The DNA content, however, was always higher in root and shoot of the K-deficient plants, but lower in case of P-deficient plants. In case of leaf at the first harvest the pattern of DNA content was similar to root and shoot but K-deficient plants have a higher values as compared to control. At the second harvest the control plants recorded higher values than either K- or P-deficient plants.

At present we only suggest that mineral deficiency affects the metabolic pool of plants through the nucleic acid levels. There is a definite decrease of nucleic acid content in P-deficient plants. However, the role of K in regulating the nucleic acid levels is not very clear.

Our grateful thanks are due to Professor R. N. Tandon for providing us necessary laboratory facilities for this work. Thanks are also due to Miss S. Abbas Naqvi for her valuable suggestions during the course of the experiment.

Department of Botany, SHRI RANJAN.  
University of Allahabad, R. M. PANDEY.  
Allahabad (India), July 26, 1962.

1. Arnon, D. I. and Hoagland, D. R., *Soil Sci.*, 1940, 50, 643.
2. Ogur, M. and Rosen, G., "The nucleic acids of tissues I," *Arch. Biochem.*, 1950, 25, 262.

### A NEW *ALTERNARIA* BLIGHT OF *CELOSIA CRISTATA* L. FROM INDIA

In the course of his studies on the fungus genus *Alternaria* occurring in Bombay-Maharashtra (India), the author noticed several plants of *Celosia cristata* L. showing severe leaf-blight in a flower garden at Pimpri (Poona) during the monsoon months of 1961. The disease manifested itself in the form of circular concentric rusty-

brown necrotic areas mainly confined to the leaves, resulting in severe defoliation. The infected leaves showed abundant sporulation specially when kept under moist chamber, producing solitary conidia with unusually long beaks. The fungus was readily isolated in pure culture and proved highly pathogenic under artificial inoculation experiments.

The disease developed rapidly under high humidity conditions reducing the incubation period from one week in the open to five days in the bell-jar.

No species of *Alternaria* has been previously reported on this host. Saccardo (1899 and 1906), however, lists *Macrosporium celosiae* F. Tassi on this host and *M. amaranthi* Peck. collected from *Amaranthus retroflexus* L., a closely related host. Venkatakrishnaiah (1952) has described *Alternaria amaranthi* (Peck.) Venkata., causing blight of *Amaranthus paniculatus* L. from Bangalore (India). The Poona isolation of *Alternaria* obtained from *Celosia cristata* L. was, therefore, carefully compared with the above three species, the results of which are presented in Table I.

It is clear from these results that the Poona species of *Alternaria* isolated from *Celosia cristata* L. is significantly distinct both in morphological characters and conidial dimensions from the previously described species obtained on *Celosia cristata* L. and other closely related hosts belonging to the *Amaranthaceae* in possessing an unusually long beak, complete absence of constrictions in the conidial walls; non-septate characters of the beak; and in the significantly bigger dimensions of the conidia. The Poona *Alternaria* is therefore considered new to science and proposed as a new species with the following Latin diagnosis:

*Alternaria pimpriana* VASANT RAO SP. NOV.

Infectionis maculae epiphyllae, circulares vel concentricae annulatae; brunneae, disperse, magni-

TABLE I  
Comparison of species of *Alternaria* and *Macrosporium* affecting hosts belonging to *Amaranthaceae*

Species	Host	Conidial dimensions (including beak)	Conidial characters	Authority
1. <i>M. amaranthi</i> Peck.	<i>Amaranthus retroflexus</i> L.	36-64 $\mu$	Beak short; catenulate	Saccardo, 1899
2. <i>M. celosiae</i> F. Tassi	<i>Celosia cristata</i> L.	24-26 $\times$ 14-18 $\mu$	Non-beaked; catenulate	Saccardo, 1906
3. <i>A. amaranthi</i> (Peck.) Venkata.	<i>Amaranthus paniculatus</i> L.	31.5-71.0 $\times$ 12-20 $\mu$	Beak medium; catenulate	Venkatakrishnaiah, 1952
4. Poona fungus	<i>Celosia cristata</i> L.	205.8-260.5 $\times$ 12.5-17 $\mu$	Beak very long; solitary	..

tud. 6-10 mm. Conidiophori simplices, vulgo solitarii, multi-septati (1-7), emergentes per epidermidem, rari per stomata, constricti; geniculati, alte brunnei, rotundati ad apicem, ornati cicatrice unica,  $21-63 \times 5.2-8.5 \mu$ . Conidia solitaria, obovata vel obclavata, 5-13-septata transverse, 1-2-septata longitudinaliter, fastigata in rostrum longum; hyalinum; non-septatum; non-furcatum fere triplo conidiis longius, haud constricts ad septa, parietibus duplicibus ornata, pallide brunnea  $205.8-260.5 \times 12.5-17 \mu$  (rostrum inclusum).

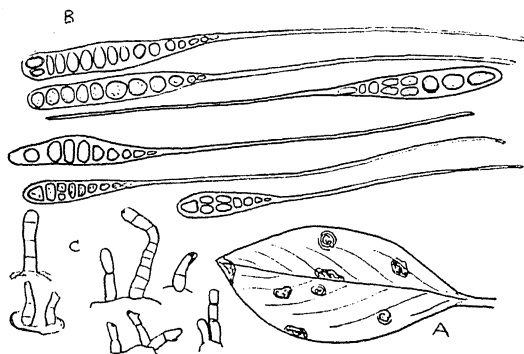


FIG. 1. A. Symptoms,  $\times \frac{1}{3}$  Nat. size. B. Conidia,  $\times 180$ . C. Conidiophores,  $\times 180$ .

In foliis viventibus *Celosia cristata* Linn. Leg. Vasant Rao, mense augusto anni 1961, ad Pimpri in India, M.A.C.S., Mycol. Herb. No. 110.

The species is described after the village Pimpri, Poona, from where it was collected. The type specimen is being deposited at the Herb. Crypt. Orientalis, New Delhi, India and Herb. C.M.I., Kew, England.

The author's thanks are due to Prof. M. N. Kamat for guidance, to the Director for facilities and to Prof. H. Santapau for the Latin diagnosis. He is also thankful to the I.C.A.R., New Delhi, for the award of a Senior Research Fellowship. M.A.C.S. Labs., VASANT GURUNATH RAO. Poona-4, July 30, 1962.

1. Saccardo, P. A., *Sylloge Fungorum*, 1899, **14**, 1095.
2. —, *Ibid.*, 1906, **18**, 619.
3. Venkatakrishnaiah, N. S., 'Blight of *Amaranthus paniculatus* L. caused by *Alternaria*,' *Phytopath.*, 1952, **42**, 668.

#### INHERITANCE OF STEM AND GLUME DISCOLOURATION IN WHEAT

IN the breeding programme for wheat resistance in wheat at the Botanical Substation of the Indian Agricultural Research Institute, one of the varieties Redman-Mentana was found to be resistant to black and brown rusts. The variety,

however, showed blackening of the stem and glumes at the milk stage of grain formation. Detailed observations indicated that the area around the nodes developed brownish colouration in the beginning and these later turned to brownish-black patches covering the glumes also with about one-third portion of most of the internodes discoloured at maturity. When the intensity was heavy the grain formation was badly affected. Affected stems and ears are shown in Fig. 1.



FIG. 1.

The variety Redman-Mentana was crossed with normal varieties like N.P. 755 and N.P. 761. Detailed observations on the  $F_1$ ,  $F_2$  and  $F_3$  generations were taken in the latter cross and the data indicated that the character was inherited. The data are presented in Tables I and II for the years 1959 and 1960.

The  $F_1$  reaction indicated the dominance of normal over discoloured and the  $F_2$  gave a ratio fitting closely to 13 normal to 3 blotched indicating that the character was dominant but inhibited by a factor present in N.P. 761.  $F_3$  data collected on random lines in 1960 are presented in Table II.

TABLE I  
Segregation for stem and glume blotching in the cross N.P. 761  $\times$  Redman-Mentana in the  $F_2$  and the  $F_1$  reactions, during 1959

Parents and cross	Number of plants		Total	Chi-square	P. value
	Normal	Blotched			
P <sub>1</sub> N.P. 761 ..	25	..	25	..	..
P <sub>2</sub> E. 2295 ..	..	36	36	..	..
F <sub>1</sub> ..	36	..	36	..	..
F <sub>2</sub> (Observed)	111	30	141	0.59	0.5-0.3
(Expected 13:3)	114.56	26.44	..	..	..

TABLE II  
 $F_2$  reactions for glume and stem blotching observed in the cross N.P. 761  $\times$  E. 2295

Material	Homozygous		Total	Chi-square (P value)
	Normal	Segregating		
N.P. 761 ..	33	..	33	..
F <sub>2</sub> Observed	46	44	90	0.714
Expected (7:8:1)	42	48	90	(0.5-0.3)
E. 2295 ..	..	..	27	..

Detailed observations on  $F_2$  segregation of higher or lower proportions of blotched to normal plants were not taken but the  $F_2$  behaviour of a ratio close to 7 normal: 8 segregating: 1 blotched clearly indicated that there were two factors conditioning the blotched character.

Botanical Substation, P. N. NARULA.  
Pusa (Bihar).

Division of Botany, Y. M. UPADHYAYA.  
Indian Agricultural

Research Institute, New Delhi-12.  
July 24, 1962.

#### A NEW RECORD OF SHOT-HOLE-BORER, *SCOLYTOPLATYPUS RAJA* BLANDAF. (SCOLYTIDAE: COL.) OF APPLE TREES IN H.P.

THE members of the Scolytidae family constitute some of the most serious and destructive forest pests. They have also been reported as vectors of certain fungal diseases of coniferous and deciduous trees. The Dutch elm fungus disease *Ceratocytis ulmi* (Buisman) Moreau, has been reported to be transmitted from diseased to healthy trees by the scolytid beetles. *Scolytus multistriatus* (Marsh.), *S. scolytus* F., and *Hylurgopinus rufipes* (Eichh.). Katsumata considered *Scolytoptatypus daimie* Blandaf. as a probable insect vector of the fungus *Endothia parasitica* (Murr.) in chestnut trees. Various species of scolytid beetles are also known to

cause considerable damage to deciduous fruit trees in U.S.A., Australia and European countries, and even rubber and tea plants in Java.

Recently at Kotgarh (Himachal Pradesh), some apple trees, apparently suffering from fungal disease, on examination, were found to be infested with a scolytid beetle. The beetle has been identified as *Scolytoptatypus raja* Blandaf. at the Indian Agricultural Research Institute. The infestation was found to be localised on certain trees and the damage to the infested plants was quite serious. The adult beetle is reddish-black and about 2.5 mm. in length and nearly half as wide. They tunnel into the sap wood and the hard wood of the trunks and branches of the tree and make 'pin-holes' in which the females lay eggs. The grubs make small vertical parallel tunnels in the entire thickness of the tree trunks and branches, thus obstructing the normal flow of the sap. At the end of the gallery the full-grown grub makes a pupal cell in which it pupates. The adults emerge outward through the parent hole. The surface of the infested branch gets perforated with small shot-hole-like openings from which the beetle gets the name shot-hole-borer. As a result of high infestation, wilting and yellowing of the foliage occur, which is generally followed by the death of the tree. The infested branches emit noxious fermenting odour on breaking.

For the control of these borers attacking deciduous and coniferous trees, application of systemic insecticides through soil, bark, or implanting into the tree trunks has been recommended by various workers.<sup>2-5</sup> With a view to control the borer infesting apple trees at Kotgarh, Metasystox at a concentration of .025 to .0375% was applied as spray on the tree during May. This gave very encouraging results and the treated plants seemed to put on new colour and healthy foliage.

We are thankful to Dr. L. S. Negi, Director of Agriculture, Himachal Pradesh, for his encouraging guidance.

Entomological Section, O. P. BHALLA.  
Department of Agriculture, P. L. SHARMA.  
Himachal Pradesh,  
Naubahar, Simla-2, August 29, 1962.

1. Katsumata, K., *J. Plant Prot.*, 1940, 27 (3), 194.
2. Kinghorn, J. M., *Jour. Econ. Ent.*, 1955, 48, 501.
3. Ripper, W. E., *Adv. in Pest Control Res.*, 1957, 1, 305.
4. Central States Forest Expt. Sta., Columbus, Ohio, *Ann. Rept. Mimeo*, 1957, p. 51.
5. Giese, R. L., Benjamin, D. M. and Casida, J. E., *Jour. Econ. Ent.*, 1958, 51 (3), 400.

## REVIEWS

### Introduction to Theoretical Physical Chemistry.

By Dr. Sidney Golden. (Addison-Wesley Publishing Co., Inc., Massachusetts, U.S.A.), 1961. Pp. xi + 307. Price \$10.75.

The book deals with the basic theoretical analysis of thermodynamics, statistical mechanics and quantum mechanics. The object of the book is to enable the student to understand the mathematical interpretation of the empirical facts that are basic to each discipline and develop in him an appreciation of the abstract concepts of the processes involved. The first 37 pages deal with classical thermodynamics including the laws of thermodynamics, thermodynamics of dilute solutions, conditions of thermodynamic equilibrium and solution theory. Statistical thermodynamics is dealt with, in the next 100 pages. The Maxwell-Boltzmann method is applied in detail for the ideal gas systems and the application of the Fermi-Dirac statistics and the Bose-Einstein statistics to ideal gas systems are also dealt with in this section. Statistical Thermodynamic version of Debye-Huckel theory, Debye's theory of specific heats and Bragg-William theory of order-disorder in solids have been well presented in this part. The next 100 pages are devoted to survey of wave mechanics dealing with stationary solutions of Schroedinger's equation, non-classical behaviour, algebraic methods for stationary states and finally, non-stationary states. In these chapters one could have expected some important topics like the treatment of the hydrogen atom and a detailed discussion on electron spin. Considerations of space might have come in the way of inclusion of these topics.

A student of Physical Chemistry generally thinks of application of the abstract ideas to numerical problems. But in the volume under review the author is more concerned with the verification of equations and the application of the abstract ideas to hypothetical systems. The interest and the understanding of the subject could have been greatly enhanced if the author had worked out a few numerical examples. The book as a whole could be useful to a graduate student who has a good mathematical background. It has a great appeal to one who is above average and has natural inclination towards mathematical development of the sub-

ject. Appendices dealing with some of the mathematical derivations would have been very helpful.

M. R. A.

**Practical Physical Chemistry.** By Arthur M. James. (Published by J. and A. Churchill Ltd., London), 1961. Pp. i-xiv + 339. Price 45 sh.

The frontiers of chemistry have moved a long way in the last few decades and they are moving even more rapidly to-day. It has become extremely important to reorient our training programme of the young aspirants in colleges and universities. It is needless to emphasise that if the students are not given an opportunity to become familiar with a variety of modern developments and new techniques, they will be handicapped in their later career as chemists. The difficulty of selection of experiments for practical training increases with time because of the phenomenal accumulation of literature on newer methods employing new apparatus and techniques which is expanding at an explosive rate. Commercial instrument manufacturers have developed so many new and improved gadgets and are flooding the scientific market and it has become extremely difficult to give any preferential selection. Any serious effort to inculcate these modern developments in the instructional courses is a welcome feature.

The book under review which the author modestly calls as 'a Laboratory Manual of Physical Chemistry' illustrates the principles of physical chemistry and gives a good guidance to train the students in experimentation and helps to develop familiarity with apparatus and to encourage the young aspirant in his ability to do research. Over 160 experiments have been designed under 11 units starting from Chapters 5-15. The first chapter provides a very useful account of "Errors and the Mathematical Treatment of Results". This is followed by three chapters on Instrumentation of all kinds to be found in a modern Chemical Laboratory. The book is complete with Bibliography, Tables of some Physico-chemical Constants, List of Principal Symbols, Index and Logarithmic Tables. Although modern techniques such as Chromatography, Electrophoresis, Ion Exchange, Complexometry are illustrated, Tracer

techniques and gadgets making use of semi-conductors, thermistors, etc., could have found a place in the treatment.

This manual will receive appreciation from the student community and the teacher as well as those who are interested in the training and research programme in the field of chemistry.

A. R. V.

**Introductory Organic Quantum Chemistry.** By Georg Karagounis. Translated and edited by F. C. Nachod. (Academic Press, New York); 1962. Pp. 204. Price \$ 6.50.

This book is an English translation of the German text bearing the title, "Einführung in die elektronen theori Organischer Verbindungen". The German title is much nearer a correct description of the contents of this volume.

The plan of the book is commendable in its brevity, lucidity and organisation of the chapters—building up from the fundamentals of the Planck's constant, the Bohr atomic model, the Schrodinger equation, the covalent bond, the V.B. and the M.O. methods followed by chapters dealing with their application in determining or interpreting molecular properties like dipole moment, molar refraction, magnetic susceptibility and chemical equilibria. There is even a short chapter on Nuclear magnetic resonance spectroscopy and chemical constitution, in its simplest version. The longest chapters, of 24 and 21 pages, deal with colour, chemical constitution and mesomerism; and chemical reactivity from the view-point of electronic theory. Of the two, the former presents with much clarity the influence of quantum mechanical approach in interpreting electronic absorptions of organic molecules, especially dyes. The rest of the book is hardly distinguishable from any other standard text dealing with Valency, Molecular structure or electronic aspects of the chemical bond.

The language in translation from the German original seems to suffer by bad construction in many parts, for instance on page 122, one finds a statement, "The measured total molar susceptibility is the sum of the always present diamagnetic susceptibility and the possibly occurring paramagnetism". At times one even encounters contradictory statements like, "This goes so far that triphenylamine can no longer add HCl" (page 135) while on page 171, it says, "Triphenylamine has the ability to form salt which would require addition of a proton to the lone electron pair". Similarly, read out of context the following sentence on page 132 would seem

odd, "The carboxylic group becomes even more positive by the dissociation of the proton", while one infers from the context that the more positive the carboxylic carbon, the more easily it loses the proton. A number of printing mistakes are obvious even on a cursory survey. The penta-covalent Nitrogen on page 125 is an incorrect representation of the amine oxide form.

The Claisen rearrangement cited as an example of electrophilic rearrangement (page 185) is not too happy a choice since it has not thus far been demonstrated decisively to be electrophilic.

The book lists many useful references at appropriate places and many of these are to quite recent publications—as recent as 1961. A list of books for further study is also incorporated at the end of the book.

There is a suggestion in the book to replace the term bathochromic with bathychromic in describing red shifts in spectra. The latter term is closer to the meaning of "colour deepening" depth being denoted by *bathy*. The reviewer is inclined to agree with and underscore this suggestion.

The extensive literature references and the clarity of the ideas expressed in this book would commend the book highly to beginners of electronic theory of organic chemistry. It would be a useful adjunct to any general monograph on Valency and Molecular structure.

B. S. THYAGARAJAN.

**The Physical Chemistry of Metallurgical Processes.** By A. K. Biswas and G. R. Bashforth. (Chapman and Hall, London), 1962 Pp. 336. Price 50 sh. net.

Despite all the scientific advances in the metal industry and technology, metal production today still maintains its touch of 'art'. Also there is a growing realisation that any proper understanding of the 'art' involves a thorough appreciation and knowledge of the physical chemistry and thermodynamic principles of the processes. Dispersed as these work and data are in numerous journals, the authors have ably attempted in this book to bring under one cover the various background principles and their application to metal production processes of significance and utility to not only to the operator on the furnace floor but also to the student and researcher in production metallurgy.

The book has been conveniently divided into 19 chapters and an appendix.

Developing the subjects of physical chemistry and thermodynamics gradually the authors open



out the first few chapters with the several well-known basic principles, laws of transformation of energy in a system, concept of equilibrium, affinity, and maximum work. Following on they discuss in some detail ideal and non-ideal solutions, the 'free energy' of a system, and the Heat theorem and the velocity of a reaction, diffusion and catalysis.

The science of mutual transformation of chemical and electrical energies are discussed under the caption 'electrochemistry' in a separate chapter.

The phase rule, the determination of Heat capacity, enthalpy, free energy, the measurement of activity, vapour pressure, dissociation pressures, are discussed next in some detail.

Next follows the discussion in detail of some of the important Metallurgical equilibria, like gas metal reactions, equilibrium in the Blast furnace, carburization and decarburization equilibrium and slag-metal equilibria. The deleterious significance of gases in steel and their removal are dealt with next.

Data of practical significance to production metallurgy are furnished under the captions Reduction and Oxidation, and a detailed discussion on the role, significance and importance of slags in reduction metallurgy in the last chapter.

The text in the book under review has been very well complimented with a large number of graphs and tables, and in its present form will prove itself to be a very useful reference to the serious student of and practical operator in production metallurgy.

A. A. KRISHNAN.

**The Science of Flames and Furnaces**, 2nd Edition. By M. W. Thring. (Chapman and Hall Ltd., London W.C. 2); 1962. Pp. 625. Price 80 sh.

When Professor Thring's book, *The Science of Flames and Furnaces* was first published in 1952 it filled a serious gap that existed between theory and practice of furnace design. In the present second edition, the text has been substantially revised and extended to cover latest developments. The general arrangement of the chapters, however, remains unaltered.

The book is divided into the following seven chapters: (1) The Function of a Furnace, (2) The thermodynamics of Furnace Heating, (3) The Liberation of Heat by Combustion, (4) Heat Transfer, (5) The Aerodynamics of Hot Systems, (6) The Science of Furnace Construction, (7) The Application of Scientific Methods to Furnaces,

At the end of each of the last four chapters useful summaries have been provided which help in recapitulation of the vast data presented. There is a useful table of conversion factors. Author index and subject index have also been provided.

The book is extremely well written and authoritative as one should expect from Prof. Thring who is an accepted authority on the subject and who is so well known for his extensive researches in the field of flames and furnaces. However, it is rather disappointing from the standard point of chemical engineers inasmuch as sufficient justice has not been done to furnaces used in the chemical industry. Perhaps we could expect a separate book on the subject of Furnaces for the Chemical Industry from the author.

The book is very useful to furnace designers, furnace operators and research workers in the field of flames and furnaces and everyone in this category is recommended to have a personal copy of the book. The book should find a place in every scientific and technological library.

N. R. KULLOOR.

**Mineral Metabolism—An Advanced Treatise**, Volume I. Part A and B. (*Principles, Processes and Systems.*) Edited by C. L. Coniar and Felix Bronur. (Academic Press Inc., New York-3, N.Y.), 1960-61. Part A: Pp. xv + 416. Price \$12.00; Part B: Pp. xv + 538. Price \$14.50.

Since the publication by Stahl in 1939 his monumental work on mineral metabolism this is the first time a comprehensive treatise on mineral metabolism has appeared. In this gap of two decades there had been tremendous development in the understanding of the role of minerals in intermediary metabolism. Newer techniques in the isotopes and their applications in biology and medicine have added a tremendous wealth of knowledge. These have been reviewed in the book by leaders in the field. In Part A, the first five chapters are devoted to a discussion on various physical and mathematical aspects of homeostasis. In Chapter 6, the general aspects of ion transport and the electrical and energetic interrelationships are discussed. A general review on body fluid dynamics is given in Chapter 7.

The last three chapters on intestinal absorption and excretion, renal excretory mechanism and extrarenal regulation with special reference to sweat are of special interest to biochemists, physiologists and clinicians,

Part B presents various aspects of mineral metabolism with particular emphasis on: (1) hormonal control of mineral metabolism, (2) the composition and kinetics of mineral turnover in connective tissue, bone and teeth, (3) the role of metal ions in enzyme reaction.

It is noteworthy that this volume is a remarkable compilation of various aspects of modern concepts and role of metabolism of various ions. Both Parts A and B of Volume I are well edited and have very little editorial error. The editors and the authors of the various articles deserve our compliments for the lucid way the articles have been written and organised. The bibliographies are quite extensive and up-to-date. This volume will be of immense value to everyone interested in metabolism and particularly to the specialist as a reference book. This reviewer highly recommends this book to serve as a reference text for advanced students in biological sciences.

B. K. BACHHAWAT.

**Elements of Indian Stratigraphy.** By S. K. Boroah. (Published by Dattsons, Nagpur), 1962. Pp. 207. Price Rs. 8-25.

According to the author, this book is intended to be a compendium of Indian Stratigraphy, and to some extent, this objective has been achieved. The main features of the various stratigraphical systems have been described in sufficient detail to be useful for University students of the B.Sc. standard. The printing of the book, however, leaves much to be desired. There are numerous typographical errors, the most serious from the point of view of the student being the mis-spelling of names of fossils. The text-figures (both outlines and lettering) are very poor. Page numbers have not been noted against several entries in the Index.

C. S. P.

**Blood Vessels and Lymphatics.** By D. I. Abramson. (Academic Press Inc., New York-3, N.Y.), 1962. Pp. xx + 812, Price \$ 26.00.

The book *Blood Vessels and Lymphatics* edited by David I. Abramson and published by Academic Press is a well-edited succinct summary of the present knowledge of the vascular systems and the lymphatics. There have been very little overlapping information in the sections in spite of there being 52 contributors, some of whom, contribute to more than one aspect of the subject. The book is more didactic than discursive, some of the

chapters being all too brief. A number of pictures, as seen by the electron microscope, have been added to make the text more illuminating. The chapters on micro-circulation would be a little confusing to the uninitiated reader. In the chapters on the special vascular beds, the question of coronary circulation has been discussed well, but the statistical aspect of what artery is affected most under Indian conditions, as we in India would require, is yet to be known; how anæmic and hypopietic conditions contribute towards the coronary thrombotic conditions is also discussed only vaguely. Whereas vascular beds of musculatures—striped or unstriped—have been fully gone into, yet the question of special musculature of the heart under active conditions of varying degrees as assessed by clinical conditions—fibrillary or other—leaves the problems unsolved. The *pituitary* and *thyroid* circulations are indeed well discussed. Renal hepatic and lineal circulations have been dealt with in detail and one learns a great deal from the material presented. Collagenases and the pathological conditions—the so-called collagen diseases—like L.E., etc., bring forth vividly the available knowledge on circulatory disturbances affecting the collagens. Pathological conditions of the venous system have been discussed rather perfunctorily and the bacteriological aspects of the question has not been taken up at all. The discussion on the lymphatics system are some of the best chapters of the book, and for the first time we see the physiology of the lymphatic system presented so ably. However, whereas photographs of the lymphatic obstructions unilaterally, etc., are presented, there is no indication of protozoal infections giving rise to lymphatic obstruction, and the sequelae following thereon are not even touched upon, especially obstruction by *Wuchereria bancrofti*—which plagues half the world.

The book is printed on extremely good paper with no errors. The price of the book indicates that it can only be purchased by specialised libraries catering to advanced students.

C. V. NATARAJAN.

**Fish in Nutrition.** Edited by E. Heen and R. Kreuzer. (Fishing News Books Ltd., Ludgate House, London E.C. 4), 1962. Pp. xxiii + 447. Price £ 6.6 sh.

The present volume is the outcome of an FAO Conference on "Fish in Nutrition" held in Washington in September 1961. The Conference was attended by about three hundred participants from many countries. 71 papers submitted

by 166 experts from 24 nations together with brief accounts of discussions are published in this volume. The Conference, among other things, focussed world attention on the importance of fish as a source of protein in human diets especially in countries where protein malnutrition is widely prevalent. The publication consists of five parts, (i) The role of fish in world nutrition; (ii) Chemical components of fish and their changes under treatment, (iii) Contribution of fish and fish products to National diets, (iv) Fish and fishery products in animal nutrition and (v) Demand for fish as human food and possibilities for increased consumption.

In the first part, five papers dealing with fisheries resources, production and utilisation in relation to human and animal nutrition are presented. Certain problems such as potential fisheries resources of the sea, and practicability of increasing the fish production in tropical and sub-tropical regions using improved methods of fish production have been discussed. The second part contains 28 papers under the three heads, (i) Proteins and general composition; (ii) Lipids and vitamins and (iii) Influence of processing. The third part contains 17 papers concerning various aspects of the contribution of fish and fish products to National diets with particular reference to fish proteins and lipids. The role of fish and fish products in the treatment and prevention of protein malnutrition in children has also been discussed. Part four contains 14 papers covering various aspects of the contribution of fish and fishery products in animal nutrition. The importance of fish products as a source of nutrients in the diets of poultry, pigs and ruminants has been stressed. The fifth and concluding part contains 7 papers relating to technological developments in different countries in the production and consumption of fish flour as human food.

The proceedings of the Conference represent, for the first time, an attempt to bring before the world the various means of increasing fish production and its preservation and utilisation to meet the growing protein needs of the developing countries. Great credit is due to FAO for organizing this Conference and for having brought out a highly authoritative publication dealing with various aspects of fish in human nutrition. The get-up of the book is excellent. This volume can be highly recommended as an authentic source book and reference manual to research workers in the field of fisheries, food technology and nutrition. M. SWAMINATHAN.

**Elementary Zoology.** By M. A. Moghe. (Macmillan and Co., Madras-2), 1962. Pp. viii + 311. Price Rs. 6-50.

This publication primarily intended for Pre-University, Pre-Degree and Higher Secondary students commences with some biological considerations and deals with the cell, as a general unit of organization using *Amoeba* as an example. The various tissues are described. It is followed by a detailed description of the Frog to elucidate the fundamentals of form and structure and functions of a living organism.

Classification of animals of the major phyla to elucidate the patterns of organisation is illustrated by using a few type forms like *Hydra*, the Earthworm and the Cockroach.

The language is simple and the illustrations are from books and memoirs of well-known zoologists.

One wonders whether the description of Mitosis should not have been a little more accurate.

The index does not appear to have been checked well, as for example, zooid on page 311.

Despite these minor blemishes, the book should be of use for the primary purpose for which it is intended.

P. A. R.

#### Books Received

*Modern World Series*—No. 2: *Progress in Science*, pp. 63; No. 3: *Research and Discovery*, pp. 103. (British Information Service, Chanakyapuri, New Delhi-21), 1962. Price (not given).

*Royal Institute of Chemistry Monograph No. 6—Principles of Titrimetric Analysis.* By E. E. Aynsley and A. B. Littlewood. (Royal Institute of Chemistry, London W.C. 1), 1962. Pp. 42. Price 4 sh. 6 d.

*The Manufacture of Iron and Steel (Vol. 4)—The Mechanical Treatment of Steel.* By G. R. Bashforth. (Chapman and Hall, London W.C. 2), 1962. Pp. viii + 276. Price 45 sh.

*Chemie Im Dienst Der Archäologie Bautechnik Denkmalpflege.* By J. A. Hedvall. (Akademiforlaget, Gumperts, Goteborg), 1962. Pp. x + 229. Price (not given).

*Bats.* By G. M. Allen. (Dover Publications, Inc., 180, Varick Street, New York 14, N.Y.), 1962. Pp. x + 368. Price \$ 2.00.

*Fluid Dynamics.* By G. H. A. Cole. (Methuen's Monographs, Methuen and Co. Ltd., 36 Essex Street, London W.C. 2), 1962. Pp. xiii + 238. Price 25 sh.

*Vaucheriaceae*. By G. S. Venkataraman. (Indian Council of Agricultural Research, New Delhi), 1961. Pp. v + 112. Price (not given).

*International Series of Monographs on Nuclear Energy-Reactor Safeguards*. (Pergamon Press, Headington Hill Hall, Oxford); 1962. Pp. ix + 390. Price 80 sh.

*Advances in X-Ray Analysis* (Vol. 5). Edited by W. M. Mueller. (Plenum Press, Inc., 227; West 17th Street, New York-11), 1962. Pp. xi + 564. Price \$ 17.50.

*The Universe and Man*. By Paul Bergsoe. (Methuen and Co., London W.C. 2), 1962. Pp. x + 234. Price 36 sh.

*Advances in Computers* (Vol. 3). By F. L. Alt and M. Rubinoff. (Academic Press, New York and London), 1962. Pp. xiii + 361. Price \$ 12.00.

*Symposium of the International Society for Cell Biology*. (Vol. I)—*The Interpretation of Ultrastructure*. Edited by R. J. C. Harris. (Academic Press, New York), 1962. Pp. x + 438. Price \$ 14.00.

*Symposium of the Society for Experimental Biology* No. XVI—*Biological Receptor Mechanisms*. (Cambridge University Press, London N.W. 1), 1962. Pp. vi + 372. Price 50 sh.

*The Biology of Cilia and Flagella*. By M. A. Sleight. (Pergamon Press, Headington Hill Hall, Oxford), 1962. Pp. xiii + 242. Price 70 sh.

*Adsorption and Collective Paramagnetism*. By P. M. Selwood. (Academic Press, New York and London), 1962. Pp. ix + 189. Price \$ 7.50.

*Practical Chemistry an Integrated Course*. By J. W. Buttle and D. J. Daniels. (Butterworths, London W.C. 2), 1962. Pp. xi + 294. Price 21 sh.

## SCIENCE NOTES AND NEWS

### Award of Research Degree

Andhra University has awarded the D.Sc. degree in Geophysics to Shri P. Jaganmohana Rao for his thesis entitled "Studies on Local Heat Balance at Waltair".

### Indian Journal of Pharmacy—Silver Jubilee Year

The *Indian Journal of Pharmacy* was started in 1939 at Benares as "a quarterly Journal devoted to the science and practice of Pharmacy in all its branches". It became the official publication of the Indian Pharmaceutical Association in the next year. The publication offices were transferred to Bombay in 1946. The Journal was converted into a bimonthly in 1949 and from the following year it has been appearing as a monthly periodical.

The Journal has successfully served as a medium for the publication of the results of researches carried out in the various branches of pharmacy both in academic institutions and in pharmaceutical industry. Other features of the Journal are Technical Notes, Hospital Pharmacy, New Products and Equipment and Forensic Notes.

The *Indian Journal of Pharmacy* enters the Silver Jubilee Year—the 25th year—of its publication and proposes to celebrate it by publishing enlarged issues featuring a number of special articles.

### "Discovery" to Join the Indian Ocean Expedition

Britain's research ship, the *Discovery*, will leave London shortly for an 18-month voyage as part of the international Indian Ocean expedition. The *Discovery*, which is one of the best equipped research vessels will carry a team of 20 scientists and is to join two other British survey vessels already taking part.

Among the many problems to be investigated by scientists on board the *Discovery* in the Indian Ocean are those relating to the manganese nodules known to be present at the bottom of the ocean, and meteorological and oceanographic conditions affecting marine life in this virtually unknown sea. The scientists hope to make a full assessment of the extent of the nodule deposits and their economic value to neighbouring lands. They will also use underwater equipment for detecting concentrations of fish and marine animals.

### Natural Triploid in Brinjal (*Solanum melongena*, Linn.)

Messrs. V. M. Chavan, D. G. Bhapkar and D. P. Bhoré of the Agricultural College, Poona, write: During the hot weather season of 1961-62, a very vigorous plant was observed in a brinjal (variety *manjri-gota*) plot at the Agricultural College Farm, Poona. It showed peculiarities in flower, all the flowers being long styled which

is not common in the above variety. Cytological investigations showed that the haploid number of chromosomes in this plant was eighteen, containing very often 17 bivalents and two univalents, thus showing a triploid origin since normal (diploid) has the haploid number of twelve.

#### Inheritance of Some Seed Characters in Broad Beans (*Vicia faba* Linn.)

Shri R. D. Goyal, Government Research Farm, P.O. Nawabganj, Kanpur (U.P.), writes: Reciprocal crosses made between two widely different varieties of Broad Beans, a 'local' and an imported 'windsor', revealed that the characters for shape, colour and dimpled nature of the seed behaved independent of one another and had no linkage among the genes determining them. 'Rectangular seed with rounded ends' is dominant over 'oval' seed. Similarly, 'dark blackish-brown seed with light brown patches' is dominant over 'yellow' seed. 'Dimpled' seed is dominant over 'non-dimpled' seed. Segregation studies in F<sub>2</sub> for each character studied separately expressed a typical mono-hybrid ratio of 3:1 in each case.

#### Oldest Fossils

In 1954, Barghoorn and Tyler discovered the fossil remains of a group of fungi and algae in a Precambrian formation near Schreiber, a town in Central Ontario, near Lake Superior. The fossils include two primitive species of fungus, probably belonging to the calcareous flagellates and two types of blue-green alga, the last resembling species still living. Barghoorn and Tyler put the age of the fossils as two billion years old on geological grounds.

Hurley and his associates of M.I.T. have recently reported in the *Journal of Geology*, the results of their radioactive dating of the Schreiber fossils. Using potassium-argon and strontium-rubidium techniques they have dated these fossils as being 1.7 to 2.1 billion years old.

#### Stimulated Raman Scattering from Organic Liquids

When a liquid laser is operated in conjunction with a ruby laser it has been observed that the spectrum of the light emission from the liquid contains simultaneously with the ruby line 6943 Å (14402 cm<sup>-1</sup>), other lines which are shifted from it by amounts which coincide closely with the intense Raman shifts characteristic of the liquid. The results of this stimulated Raman scattering observed with twenty organic

liquid lasers are reported by Woodbury *et al.* in a recent issue of the *Physical Review Letters* (1962, 9, 455). Among the liquids investigated are benzene, nitrobenzene toluene, bromonaphthalene, pyridine, cyclohexane and deuterated benzene C<sub>6</sub>D<sub>6</sub>.

One notable feature in the observation on stimulated Raman scattering is that the emission shifts in certain liquids correspond not only to the fundamental Raman shifts but also to their first and second harmonics.

#### X-Rays from Sources Outside the Solar System

Data of a rocket experiment carried out to study fluorescence X-rays of solar origin from the moon and the night sky have given evidence of soft X-rays coming from sources outside the solar system. The experiment was conducted with an Aerobee rocket equipped with sensitive X-ray counters, launched at midnight on June 18, 1962 from the White Sands Missile Range, New Mexico. The rocket's payload consisted of Geiger counters fitted with lampblack (to shut off ultra-violet light transmission) mica windows 20 cm.<sup>2</sup> area and thicknesses varying from 0.2 mil. to 1.0 mil. The counters were designed to detect soft X-rays in the wavelength range 2-8 Å. The rocket reached a maximum altitude of 225 km. and was above 80 km. for a total of 350 seconds.

A graphical analysis of the total counts obtained during the entire flight showed a peak intensity which could be interpreted as due to a well-collimated beam of radiation coming from space against a diffuse background. It was also clear that the observed radiation could not be corpuscular but only electromagnetic in nature. The inference drawn is that the bulk of the radiation is due to a source emitting X-rays of wavelength about 3 Å, and lying outside the solar system. Synchrotron radiation by cosmic electrons is a possible mechanism for the production of these X-rays.—(*Phys. Rev. Letters*, 1962, 9, 439.)

#### Extreme High Vacuum Chamber

The National Research Corporation of Cambridge, Massachusetts, has announced the development of an extremely high vacuum chamber capable of reaching pressures even lower than those experienced in interplanetary space. The NRC Extreme High Vacuum chamber has reached pressures as low as 10<sup>-15</sup> torr—a pressure lower than that estimated to be found in interplanetary space, or millions of miles from earth. This is some 10,000 times lower pressure than that reached by the best chambers available for

space simulation in the aerospace industry which go down to  $10^{-11}$  torr, comparable to 800 miles above earth.

At  $10^{-15}$  torr, the environment is so free of gases that in space a molecule would travel an average of 30 million miles before colliding with another molecule. At this pressure there would be only 30 molecules per c.c. compared to  $2.5 \times 10^{19}$  molecules per c.c. at normal sea-level pressure.

The entire system of the NRC chamber is 7 ft. long and 3 ft. in diameter. The working region in which the extreme high vacuum is achieved is about half of this size. The pumping system uses oil diffusion pumps with cold caps and liquid nitrogen cooled baffles which eliminate backstreaming. On a test run the chamber reached the  $10^{-15}$  torr range in 30 hours. Typical experiments readily possible in the new facility include studies of gauges, surfaces, friction, cryogenics and pumping.—(*Jour. Frank. Inst.*, 1962, 274, 418.)

#### Data from Mars Probe

The Soviet interplanetary station Mars-I was launched on November 1, 1962. The Tass statement of January 26, 1963 says that in its about three months flight the station has covered a distance of about 230 million kilometres and is 43 million km. away from the earth. The speed of the station's movement away from earth is growing constantly. When the station was leaving the sphere of the earth's influence its speed was about 4 km./sec. Now it has grown to 10.2 km./sec.

Regular and stable radio communications are being maintained with the station. Telemetric data received on earth indicate that the temperature and pressure on board the station are

maintained at the pre-set range: temperature from 10 to 15° C. and pressure 850 mm. Exposure to light has diminished considerably because the distance between the sun and the probe has increased. Therefore, according to the flight programme, on January 5 the groups of elements of the solar batteries were switched into a parallel circuit.

Over 50 radio sessions with the probe have been conducted from the beginning of the flight. Over 1000 commands have been transmitted to the ship. From preliminary data it has been established that the intensity of cosmic rays in outer space increased by several tens of per cent. as compared with the measurements made in 1959. This is explained by the lesser solar activity at present. Growing intensity of cosmic radiation has also been noticed during the flight of the station which, apparently, can be explained by the drawing off of the probe from the sun.

Investigations of plasma in the near-earth zones of space has confirmed that the ionized gas envelope of the earth extends to altitudes of some 20,000 km. The existence of the highest belt of charged particles has been confirmed again. It has been found that in this belt the total number of particles captured by the geomagnetic field and their concentrations are greater than in the radiation belts situated closer to the earth.

For the first time vast data have been received on the streams of solar plasma in that part of space which is more distant from the sun than the earth. Registration of meteor particles, with masses greater than 1000 millionth part of a gram, showed a relatively high density of meteor matter at distances of up to 40-50 thousand km. from the earth. It has been found that the number of particles of such a mass decreases at greater distances.—(*Soviet News*.)

IN THOUGHT  
IN WORD  
AND  
IN DEED  
**SERVE INDIA**

*Work*  
**RESOLUTELY**  
*Raise*  
**NATIONAL EFFICIENCY**

# OUR PRESENT KNOWLEDGE OF THE INTERACTION BETWEEN THE ATMOSPHERE AND THE OCEANS\*

C. RAMASWAMY

*Meteorological Office, New Delhi*

## 1. INTRODUCTION

**T**ILL recently, the atmosphere and the oceans were generally treated more or less as two separate systems and the fact that they could, from many points of view, be considered as a very intimately coupled single system came to be realised by meteorologists and physical oceanographers only within the last decade or so. Consequent on this recognition, a considerable volume of literature has grown during the last 10 or 12 years on the subject of interaction between the atmosphere and the oceans, and this newly-acquired knowledge is bound to have a far-reaching effect on the future development of meteorology as well as oceanography.

The subject can, broadly speaking, be discussed under the following heads:

- (1) Energy exchange between the atmosphere and the oceans,
- (2) Mechanical interaction between the atmosphere and the oceans,
- (3) Chemical interaction between the atmosphere and the oceans.

It will be impossible to attempt a detailed survey of these three aspects in this short article. The author will therefore only very briefly summarise here a few recent contributions relating to energy exchange and mechanical interaction. The chemical interaction problems will be dealt with in a later article.

## 2. ENERGY EXCHANGE BETWEEN THE ATMOSPHERE AND THE OCEANS

One of the first objectives in the study of the exchange problem is to delineate at least the broad patterns of seasonal and regional variations in the major components of the energy exchange. Woodrow C. Jacobs<sup>1</sup> has, in a good measure, achieved this objective by publishing the annual and seasonal charts and tables for various components of exchange in respect of the north Atlantic and north Pacific Oceans. In this article, we shall discuss only his evaluation of two important components of exchange, namely, the rate of exchange of sensible heat

$Q_h$  and the rate of energy loss from the sea surface through evaporation,  $Q_e$ . For this purpose, he has mainly made use of the equation derived by Sverdrup<sup>2</sup>

$$E = K_a (e_w - e_a) W_a$$

Where  $E$  is the rate of evaporation,  $K_a$  is the evaporation factor at a height 'a' above the sea surface,  $e_w$  and  $e_a$  are the vapour pressures at the sea surface and at the height 'a' above the sea surface respectively and  $W_a$  is the wind speed at height 'a'. While using this equation, Jacobs adopted a mean evaporation factor  $K$  which he computed by a semi-empirical method. From the evaporation value  $E$ , he obtained the corresponding energy equivalent  $Q_e$  by multiplying it by  $L_t$ , the latent heat of vaporisation at temperature 't'.

The rate of exchange of sensible heat  $Q_h$  has been computed by Jacobs by using the equation (Jacobs<sup>1</sup>)  $Q_h = RL_t E$  cal. cm.<sup>-2</sup> day<sup>-1</sup> where  $R$ , known as the Bowen ratio, is given by the expression

$$R = 0.64 \frac{P}{1000} \left( \frac{t_w - t_a}{e_w - e_a} \right)$$

where  $t_w$  and  $t_a$  are the sea surface and air temperatures respectively,  $e_w$  is the vapour pressure at the water surface,  $e_a$  is the vapour pressure in the air and  $P$  is the atmospheric pressure (Jacobs<sup>1</sup>).

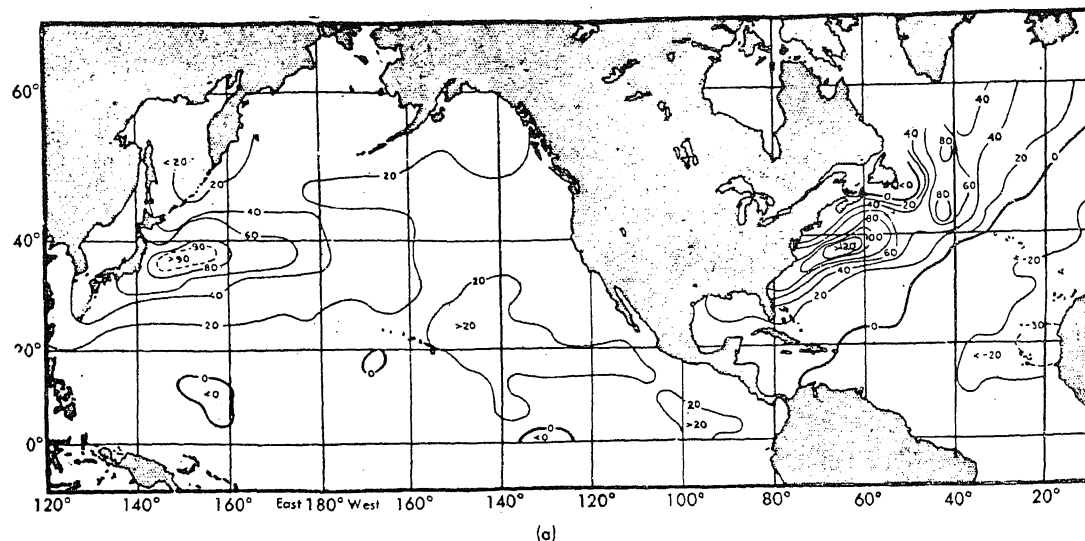
The upper diagram in Fig. 1 shows the annual values of  $Q_h$  and the lower diagram in the same figure shows the annual values of  $Q_e$ . An examination of these annual diagrams and the seasonal diagrams (not reproduced here) of  $Q_h$  and  $Q_e$  shows the following:

- (a) The isolines for  $Q_h$  show roughly the same configuration as those for  $Q_e$ . There are however no tropical areas of maximum  $Q_h$  within the trade wind regions as we have for evaporation in those areas.
- (b) The atmosphere is directly heated by the sea surface at significant rates only in the middle and high latitudes along the eastern sides of the continents. Such heating occurs principally during the winter. During summer, large areas of the sea are actually receiving some energy by conduction from the atmosphere.

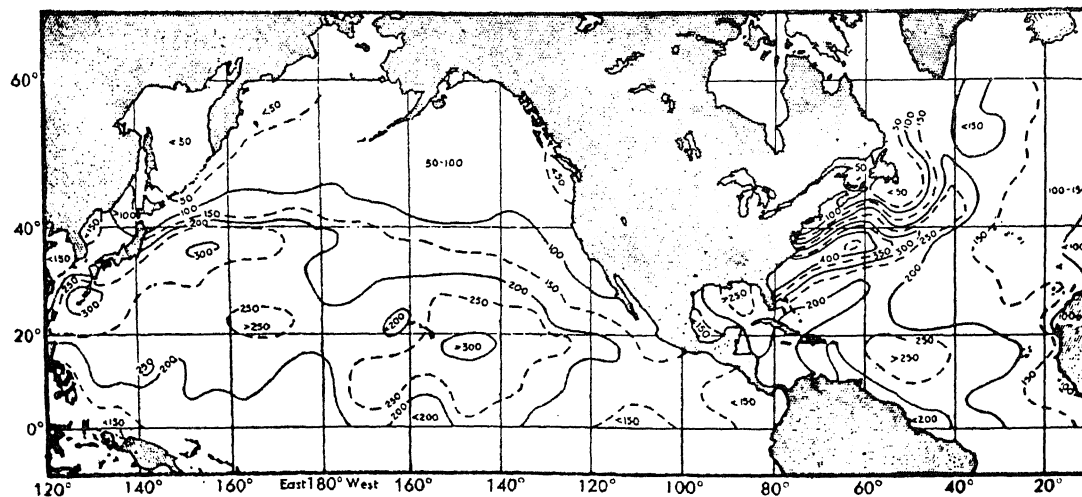
\* This review article is based mainly upon the material presented by the author during the 28th Annual Meeting of the Indian Academy of Sciences, at Bombay, in December 1962.

(c) The atmosphere is receiving moisture principally in the middle and lower latitudes.

Investigations on evaporation more or less on the same lines have been carried out by S. V. Venkateswaran<sup>3</sup> in respect of the Indian



(a)



(b)

FIG. 1. (a) The annual values of the rate of exchange of sensible heat between ocean and atmosphere  $Q_h$  over the North Atlantic and North Pacific, expressed in calories per square centimetre per day.

FIG. 1 (b). The annual values of the rate of energy loss from the sea surface, through evaporation  $Q_e$  over the North Atlantic and North Pacific expressed in calories per square centimetre per day. (The values above can be converted into rough evaporation rates by considering that the isometric interval of 50 cal. cm.<sup>-2</sup> day<sup>-1</sup> is approximately equivalent to an evaporation rate of 12 in year<sup>-1</sup>.) (From W. C. Jacobs, 1951, "Large-scale aspects of energy transformation over the oceans," *Compendium of Meteorology*, T. F. Malone, Editor, Published by American Meteorological Society through contractual support of the Air Force Cambridge Research Laboratories.

(d) There are significant maxima of  $Q_h$  as well as  $Q_e$  within the Kuroshio and the Gulf-stream.

Ocean. Combining his seasonal charts for evaporation with the precipitation charts of Jacobs, he has mapped out the excess of evapora-



tion over precipitation ( $E-P$ ) in the Indian Ocean. He has also made use of similar  $E-P$  data for other oceans and drawn a composite diagram for 'all oceans'. Figure 2 which has been reproduced from his paper shows his comparative analysis. If we remember that neither  $E$  nor  $P$  is at present directly measured, the agreement between the zonal averages for "all oceans" arrived at by independent methods must be

considered as satisfactory at latitudes which are not very close to the equator.

Another outstanding contribution which should be mentioned in this connection is the synoptic survey of the interaction between the sea and atmosphere over the north Atlantic by J. Bjerknes. Making use of the records for a 50-year period, Bjerknes<sup>4</sup> has shown how the long trend of cooling of the sea surface north of

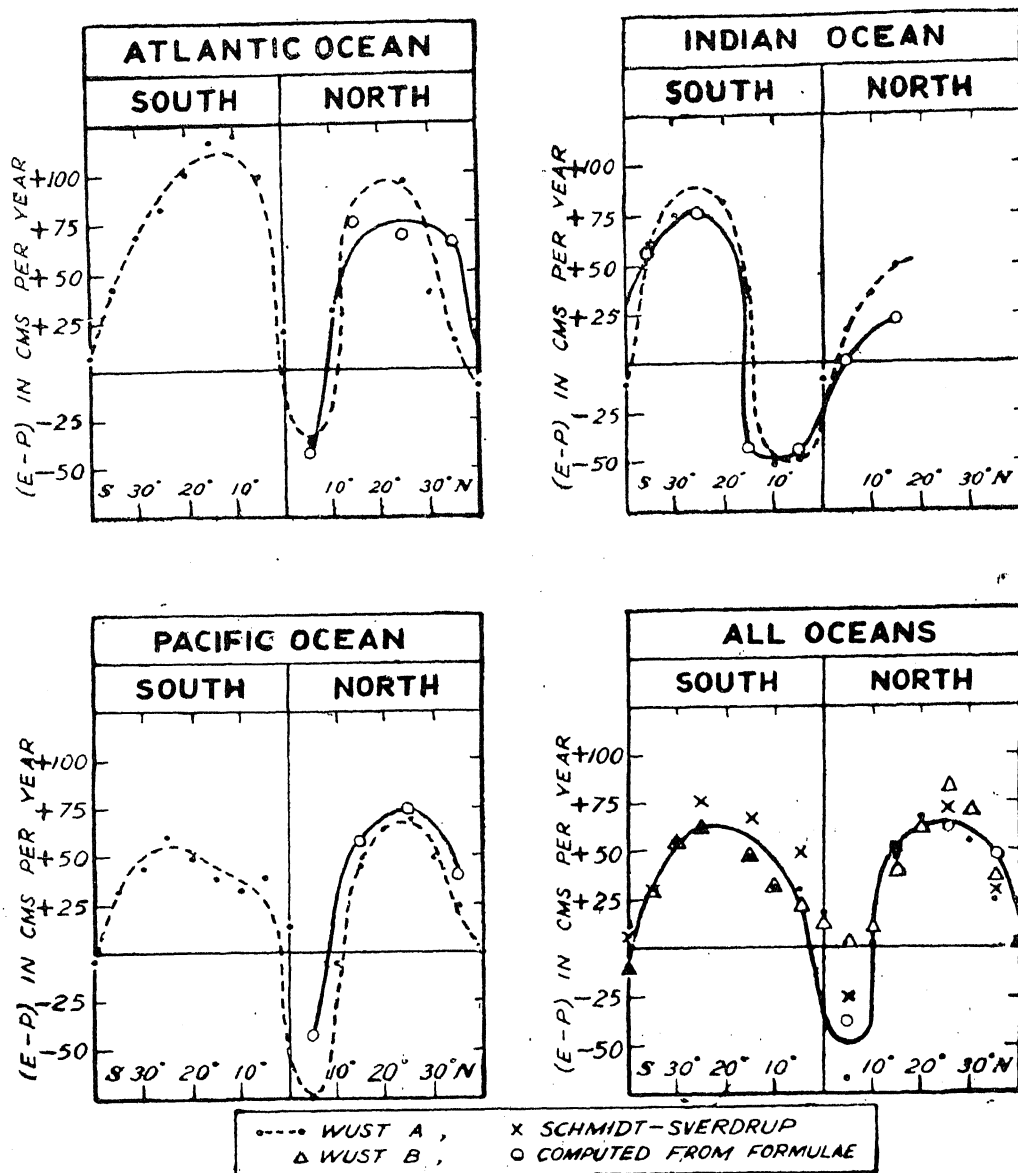


FIG. 2. Annual excess of evaporation over precipitation at different latitudes over the oceans. For the North Atlantic and North Pacific, the "computed" values are those of Jacobs while for the Indian Ocean they have been taken by the author from his own results, [From Venkateswaran, S. V., *Indian Journal of Meteorology and Geophysics*, 1956, 7 (3).]

50° N. was associated with a deepening of the semi-permanent meteorological low over the Iceland region. This deepening increased the cyclonic wind stress over that area causing thereby upwelling of the waters and lowering of the temperatures of the surface waters. Bjerknes has also shown how the intensification of the sub-tropical high during the same period, warmed up the jet-stream part of the Gulf-stream and how along with other contributory causes it intensified the jet-stream itself. These changes in the ocean produced a feed-back effect on the atmosphere and thereby prolonged the one-way trend. Bjerknes' study has clearly brought out that the climatic trends for a couple of years to two decades can be better understood by studying the interaction of the atmosphere and the oceans.

be seen from the diagram that there is a significant warming in the Jet-stream part of the Gulf-stream. The zone roughly between 50° N. and 60° N. shows a net temperature fall with maximum intensity east of 30° W. This is exactly the region where there was a net increase in cyclonic wind stress and which may have caused increased upwelling and consequent cooling of the sea surface.

In a very recent article, Gunnvald Boyum<sup>6</sup> has made use of the observations from the Ocean Weather Station 'M' at 66° N. and 2° E. collected during a period of 10 years and derived a semi-empirical expression connecting the rate of change of air temperature to the temperature difference between the sea and the air. According to his results, there should be no exchange of heat between the atmosphere and the oceanic

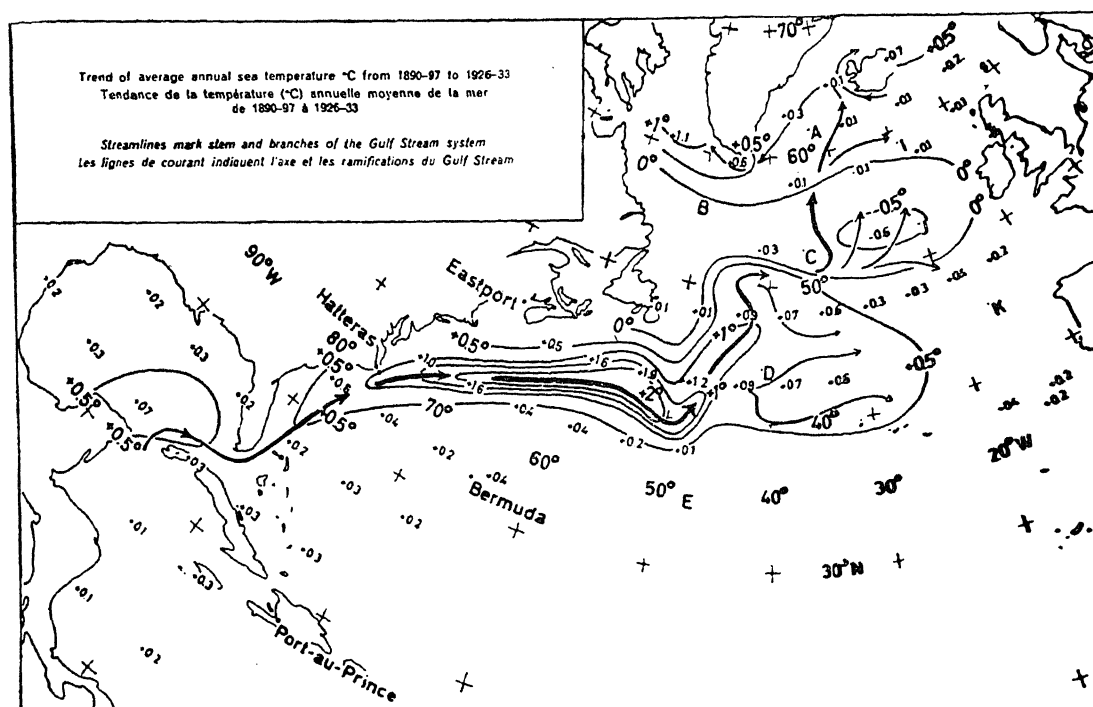


FIG. 3. The long trend of average annual sea temperature. [From Bjerknes, J., *W.M.O. Bulletin*, July 1960, 9 (3) and G. Dietrich, *Deutsche Hydrographische Zeitschrift*, 1957, Band 10, Heft, 2, pp. 39-61. Positions of present weather ships in Capital letters].

Figure 3 is a diagram reproduced from one of Bjerknes' papers. The streamlines in the diagram refer to the Gulf-stream near North America. The continuous lines represent the lines of equal differences between the average annual sea surface temperatures during the two eight-year periods 1890-97 and 1926-33. It will

surface if the difference in the temperature between the sea surface and the air is less than 0.7° C. This conclusion has received support from a recent measurement made by Ewing and McAlister<sup>7</sup> of the long wave infra-red radiation from the top 0.1 mm. of the evaporating ocean. These radiometric observations which appear

to be free from doubt show the existence of a cool surface layer characterised by departures of as much as  $0.6^{\circ}\text{C}$ . from the temperatures of the sea surface determined by conventional methods. Ewing and McAlister<sup>7</sup> conclude that the cold layer may be expected from evaporation effects and also from long wave radiation from the surface.

### 3. MECHANICAL INTERACTION BETWEEN THE ATMOSPHERE AND THE OCEANS

**Gravity Waves.**—Among the wind-generated waves which are not appreciably influenced by the deflecting force of the earth's rotation, special mention will be made here only about gravity waves. In the last decade an entirely new approach which may be referred to as the *wave-spectrum* approach has been made in regard to this problem of wind-generated gravity waves. In this approach, waves are studied by means of probability models and wave-records are analysed by statistical techniques. The sea surface disturbed by the wind is regarded as the sum of an infinite number of classical sine waves of small amplitudes extending over an infinite frequency spectrum with a specified spectral distribution of energy and having all directions of propagation. The phases of these waves are completely at random and consequently the wave-recording is completely unpredictable. "However" to quote Schule,<sup>8</sup> "the statistical properties of a recording are predictable even though the recording itself is unpredictable." The wave-recording approximates to what is known as a Gaussian process if a linear process is assumed. Based on this approach which we owe to many scientists, notably Pierson and Neumann,<sup>9</sup> a vast amount of empirical work has been done by the U.S. Navy Hydrographic Office which enables us to predict the wave characteristics in the open sea under idealised meteorological conditions.

**Wind-Driven Ocean Currents.**—Even a casual glance at any world map of ocean currents will reveal that the surface circulations in the oceans are strongest in the west. It was only about a decade ago that it was quantitatively explained by Munk<sup>10</sup> that this pronounced asymmetry with the strongest currents squeezed into a narrow belt on the western side of the oceans was a dynamical necessity for enhancing the frictional and planetary vorticity tendencies (i.e., spinning tendency due to the rotation of the earth) to orders of magnitude greater than the wind stress. According to Munk, this is the way by which we can achieve balance between the vorticity tendency in the western as well as

on the eastern sides of the oceans and obtain a steady state. This vorticity theory of the wind-driven ocean currents does not however account for several other important features of these currents, especially in the southern Hemisphere.

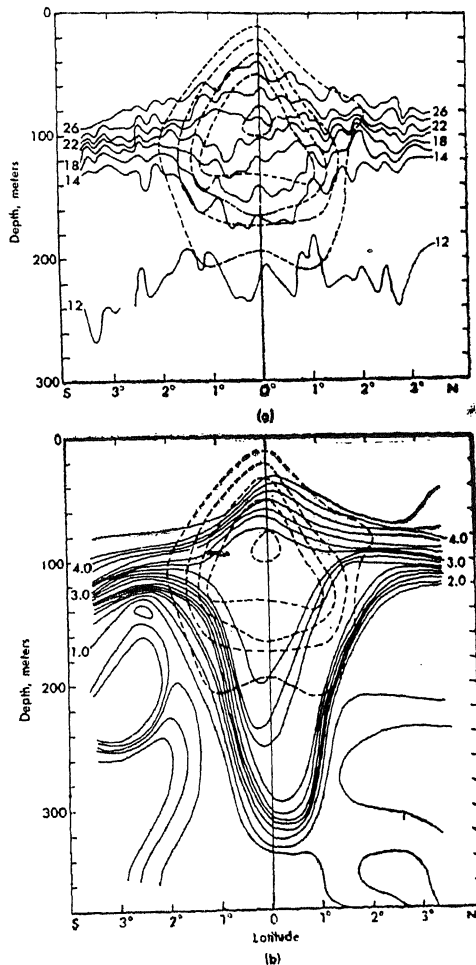


FIG. 4. Temperature and oxygen sections in the Cromwell Current in the Equatorial Pacific (Cross-section at  $140^{\circ}\text{W}$ ., 20–22 April 1958). Velocity cross-section (dashed lines) superimposed on temperature and oxygen sections. Velocity contours 25–125 cm./sec. Temperature (upper diagrams) is in degrees centigrade. Oxygen (lower diagram) is in ml./litre: (From John A. Knauss, *Deep Sea Research*, 1960, 6. Published by Pergamon Press.)

These difficulties have led to the formulation very recently of a yet another new circulation regime known as the *thermohaline* circulation. We shall not discuss this here except to state that the general circulation of the oceans as known today consists of a wind-driven gyre under the zonal wind belts and a pattern of

thermally excited transport systems which extend over the whole globe and deep down to the bottom of the oceans and which work in the same sense as the wind-driven circulations in the northern Hemisphere but, on a broad basis, oppose them in the southern Hemisphere.

*The Cromwell Current.*—One of the very recent important discoveries which has baffled Physical Oceanographers and stimulated considerable amount of thinking among dynamical oceanographers and meteorologists is the Cromwell Current known by the name of its discoverer. This sub-surface undercurrent flows eastward in the equatorial Pacific extending symmetrically on either side of the equator (Knauss<sup>11</sup>). It is considered as a major current and is characterised by low temperatures and high oxygen values (see Fig. 4). There is evidence (Gerhard Neumann<sup>12</sup>) that the equatorial Atlantic has also such a current. Neumann<sup>12</sup> concludes that one may expect to find this undercurrent in the Atlantic strongest west of 20° W. longitude and weaker towards the east.

No completely satisfactory explanation for the Cromwell Current has yet been given. Knauss<sup>11</sup> believes that upwelling "will be a necessary part of any explanation of the current". Robert S. Arthur,<sup>13</sup> Henry Stommel,<sup>14</sup> Jules G. Charney,<sup>15</sup> Allan R. Robinson<sup>16</sup> and G. Veronis<sup>17</sup> have formulated various types of theoretical models to account for the existence of this remarkable sub-surface current. All these models associate this current with the surface

wind stress. Special mention should be made here of the contribution by Jules G. Charney. He has shown that for the range of parameters applicable to the Cromwell Current, the inertial forces are as important as the frictional forces. He calculates the motion for several values of the coefficient of eddy viscosity. His calculation gives an undercurrent whose intensity increases with decreasing values of the coefficient of eddy viscosity. For sufficiently small values of eddy viscosity, the undercurrent resembles the Cromwell Current in intensity, in width and in horizontal and vertical velocity variations with depth.

1. Jacobs, Woodrow, C., "Compendium of Meteorology," *Amer. Met. Soc.*, 1951, p. 1057.
2. Sverdrup, H. U., *Ibid.*, 1951, pp. 1071.
3. Venkateswarun, S. V., *Ind. J. Met. Geophys.*, 1956, 7, 265.
4. Bjerknes, J., *Geophys. Publ.*, Joner, 1962, 24, 115.
5. —, *W.M.O. Bull.*, 1960, 9, 151.
6. Boyum, Gunnvall, *Geophys. Publ.*, Joner, 1962, XXII 7, 1.
7. Eving, G. and McAlister, E. D., *Science*, 1960, 131, 1374.
8. Schule, J. J., *W.M.O. Tech. Note*, 1962, No. 46, 1.
9. Pierson, W. J., Neumann, G. and James, R. W., *Practical Methods for Observing and Forecasting Ocean Waves*, U.S. Navy H.O. Pub. No. 603, 1955.
10. Munk, W. H., *Jour. of Met.*, 1950, 7, 79.
11. Knauss, J. A., *Deep Sea Res.*, 1959-60, 6, 265.
12. Neumann, G., *Ibid.*, 1959-60, 6, 328.
13. Arthur, Roberts, S., *Ibid.*, 1959-60, 6, 287.
14. Stommel, Henry, *Ibid.*, 1959-60, 6, 298.
15. Charney, Jules G., *Ibid.*, 1959-60, 6, 303.
16. Robinson, Allan, R., *Ibid.*, 1959-60, 6, 311.
17. Veronis, G., *Ibid.*, 1959-60, 6, 318.

## SOME ASPECTS OF THE SEASONAL AND DIURNAL CHANGES OF CIRCULATION OVER INDIA AND NEIGHBOURHOOD\*

R. ANANTHAKRISHNAN

### 1. SEASONAL VARIATIONS

THE ultimate source of energy for all weather processes is the Sun. The working substance for the atmospheric heat engine is water vapour which is transported to the atmosphere from the oceanic surface as a result of sea-air interaction. Along with it the water vapour also transports heat energy in the form of latent heat from the great oceanic reservoir to the atmosphere.

Consequent on the apparent annual movement of the Sun between the Tropic of Cancer and the Tropic of Capricorn, the solar insolation intercepted by the latitudinal belts of the two hemispheres undergoes corresponding variations. While this is the primary cause for the seasons, the seasonal changes of weather are profoundly dependent on the distribution of land and sea masses over the earth's surface because of the differences in the physical properties of soil and water in respect of their response to incident solar radiation. This differential response sets up temperature contrasts between land and sea which in turn give

\* This is a summary of the talk given at the 28th Annual Meeting of the Indian Academy of Sciences at Bombay in December 1962.

rise to pressure variations and associated air movements on which weather processes depend. The temperature and pressure patterns control the weather patterns and in turn are controlled by them. The quasi-stationary patterns of temperature, pressure and wind distribution that result from this complex chain of action and reaction are known as the seasonal patterns.

The seasonal patterns are most strikingly manifested over India and neighbourhood by the south-west or summer monsoon and the north-east or winter monsoon. The southwest monsoon has its sway over India and south-east Asia during the months June to September which is the principal rainy season for this area. During this season, the hot arid tracts of West Pakistan, Afghanistan and adjoining areas become the centre of a low pressure cell while two high pressure cells lie over the north Pacific Ocean and the south Indian Ocean respectively. The low level circulation over India and neighbourhood which is controlled by these three major pressure systems results in an inflow of air from sea to land. The low pressure area over land which is essentially of thermal origin extends up to a height of 5 or 6 Km. only. Above that level the Afghan-Tibetan plateau region becomes the seat of a high pressure cell so that there is a complete reversal of wind circulation over India and neighbourhood, the westerlies of the lower levels giving place to easterlies. Over the Indian peninsula, the easterlies increase in strength with height and attain their maximum speed near the level of the tropopause at a height of 15 to 16 Km.

Beginning from September, the south-west monsoon circulation weakens on account of decreasing insolation intercepted by the northern hemisphere. In the winter months the land-sea contrasts of temperature and pressure are reversed. Central Asia with sub-freezing temperatures is now the seat of a strong anticyclone while a low pressure cell lies over the Aleutian arc in the north Pacific and two other low pressure regions over north Australia and south-east Africa in the southern hemisphere. The low level circulation over India and adjacent areas is now directed from the land towards the sea. Winter is, therefore, the season of fine weather and bright sunshine over the greater part of India. The upper air circulation over India and neighbourhood in this season is one of solid westerlies north of latitude  $15^{\circ}$  N. The westerlies strengthen with height and attain their peak speed nearabout 12 Km. over north India.

## 2. DIURNAL VARIATIONS

Superposed on the large-scale seasonal patterns, there is a diurnal variation which is present throughout the year. The land and sea breezes experienced at coastal places like Madras and Bombay are the direct manifestations of this diurnal effect. Meteorological phenomena such as this resulting from diurnal contrasts of temperature between land and sea are a characteristic feature of the tropics. The geographical configuration of the Indian sub-continent renders this country an excellent laboratory for the study of these phenomena.

Beginning from about 1950 surface meteorological observations are being taken at the four synoptic hours of 00, 06, 12 and 18 hours GMT at some 75 observatories in India. Upper wind measurements at these four hours are also being made from many of these stations. The data which have now been collected for a period of over ten years have been utilised for the study of the diurnal variations of circulation over the country. Although the importance of the diurnal variations has been recognised by Indian meteorologists, the observational material required for a quantitative study from the synoptic and climatological angles were not available until recently. The study which the present writer and his collaborators has undertaken is still incomplete. Some of the preliminary results of the study were briefly presented at the Annual Session of the Academy. Charts showing the mean monthly isobars and winds for four representative months January, April, July and October for the four synoptic hours were exhibited. In all the months, a thermally induced low pressure area is set up over the land in the afternoons giving rise to inflow of maritime air into the country at the lower levels. In January this heat low lies over the south peninsula. In April it lies over the central parts of the country and moves further northward in May and June. With the weakening of the summer monsoon by September, the thermal low moves southward following the sun. Broadly speaking, the thermally induced circulation which builds up from morning towards evening tends to weaken the seasonal circulation in the winter months and to strengthen it in the monsoon months. As the pressure gradients of the winter season weaken by March, the diurnal circulation becomes more and more vigorous with increasing indraft of maritime air into the country, development of latent instability and increasing frequency of convective pheno-

mena such as thunderstorms and dust-storms particularly in the afternoons and evenings. The post-monsoon transitional months of October and November are also characterised by convective activity in the south of the peninsula.

The programme of work that has been undertaken comprises a detailed study of the diurnal variations of the fields of pressure, temperature and wind distribution over India and the associated effects on weather over the country.

## NEW SWEET MAIZE HYBRIDS FOR THE NORTHERN PLAINS

BHAG SINGH, N. L. DHAWAN, E. W. SPRAGUE, R. L. PALIWAL AND S. M. VAIDYA

*Division of Botany, Indian Agricultural Research Institute, New Delhi*

**T**HE roasted or boiled green ears of maize are a popular snack in this country, particularly in and around the cities. For want of suitable sweet grained types, the green ears of flint grained varieties, normally cultivated in the country, are used for this purpose. If productive sweet grained varieties and/or hybrids can be developed, a significant contribution would be made to meet the demands of kitchen gardens and farmers located around the cities.

At present sweet maize is mainly cultivated in the Kashmir Valley, where mild temperatures during the growing season, are conducive to its culture. Tests conducted over several years, at the Indian Agricultural Research Institute, with sweet maize varieties from Kashmir and U.S.A., showed that these varieties are unadapted and hence unproductive in the plains and peninsular India. A project for developing such varieties, which could be profitably cultivated in these areas, was therefore initiated.

One recessive gene *su* is normally present in the commercial sweet maize, and is responsible for the development of sweetness in sweet maize kernels.<sup>1</sup> This gene prevents the conversion of a part of the sugar into starch. Though there are modifying factors,<sup>2,3</sup> the simple mode of inheritance of the major sugary gene *su* allows for its successful transference to a highly adapted and productive flint or dent variety. The normal procedure is to make a cross between a sweet maize and a flint or dent variety possessing desirable agronomic characters, and then carrying out the conventional back-crossing programme. In this manner, the *su* gene can be transferred into different genetic backgrounds. The resulting sweet grained segregates can then be used as follows: (1) if they are true breeding and productive, then the outstanding among them can be released as an open pollinated sweet maize variety; (2) inbred lines can be developed from them for the production of top performing double cross hybrids; and (3) suitable hybrids can be developed by crossing two such segre-

gates which are genetically different but for the *su* gene.

Work along these lines was initiated at the IARI, in 1959. Two sweet maize varieties, Stowell's Evergreen and Golden Bantam, from the U.S.A., were each crossed to the adapted flint variety, Amarillo-de-Cuba (AdeC) from the Caribbean region, and the advanced generation of the semi-flint varietal cross KII × AdeC. The  $F_1$  hybrids were selfed in 1960, and from these, four genetically different crosses, sweet-grained segregates were obtained. Next the procedure outlined under item 3 above was followed to develop two sweet maize hybrids. These two hybrids were tested in a replicated randomized trial in 1962, against the four parents, three other best sweet maize varieties available and KT 41, a popular flint variety. The yields obtained with regard to green ears and dry grain are presented below along with days to silk.

Name		Yield in Kilograms/Hectare		Days to Silk
		Green ears at milk stage	Grain yield at 15% moisture	
Hybrid No. 1	..	8133	3715	48
" 2	..	5382	2561	46
Amarillo-de-Cuba (flint parent)		6219	3090	55
KII × Amarillo-de-Cuba (semi-flint parent)		7702	2921	53
Stowell's Evergreen (sweet parent)		5860	1669	48
Golden Bantam (sweet parent)		2643	1278	42
Golden 60 days	..	3719	1868	43
Extra Early Golden Bantam		2362	1458	40
Hawaiian Sugar	..	5130	2544	50
KT 41	..	6051	2403	47
C. D. at 5% level	..	1520	658	..

Hybrid No. 1 significantly outyielded the two sweet maize parents and also the flint variety, Amarillo-de-Cuba at the green ear stage, while there was no significant difference when com-

pared to KII  $\times$  AdeC. Hybrid No. 2 was only superior to the Golden Bantam parent. In grain yield, Hybrid No. 1 outyielded all the four parents, while Hybrid No. 2 gave significantly more yield than the two sweet maize parents. It will also be seen that Hybrid No. 1 was significantly better than the other entries. Moreover, it possessed one to two well-developed ears per plant which made very attractive roasted or boiled ears.

A test conducted for taste and sweetness placed the two hybrids at the top of the list. Another important character of the hybrids was their right maturity; they flowered at the same time as the local variety, KT 41 and Stowell's

Evergreen. Research is in progress to find out the range of adaptation of these hybrids in the country.

The work was carried out under the Co-ordinated Maize Breeding Scheme, and the financial help rendered by the Indian Council of Agricultural Research is gratefully acknowledged. The authors are also thankful to Dr. A. B. Joshi for suggesting the problem and for his keen interest.

1. Emerson, R. A., Beadle, G. W., and Fraser, A. C., *Cornell Uni. Agr. Exp. Sta. Mem.*, 1935, 180.
2. Jones, D. F., *Genetics*, 1919, 4, 364-93.
3. Mangelsdorf, P. C., *Ibid.*, 1947, 32, 448-58.

## INDUCED SPAWNING OF THE CHINESE CARPS *CTENOPHARYNGODON IDELLUS* (C. & V.) AND *HYPOPHthalmichthys MOLITRIX* (C. & V.) IN PONDS AT CUTTACK, INDIA

K. H. ALIKUNHI, K. K. SUKUMARAN AND S. PARAMESWARAN

Central Inland Fisheries Research Substation, Cuttack

**Introduction.**—The cultivated species of Indian carps (*Catla catla*, *Labeo rohita*, *Cirrhina mrigala*) and Chinese carps (*Ctenopharyngodon idellus*, *Hypophthalmichthys molitrix*, *Aristichthys nobilis*; *Mylopharyngodon piceus*) are riverine species which normally breed only in flooded rivers during the monsoon months, May to July. They grow rapidly and attain sexual maturity in ponds but do not breed. Young ones required for stocking are therefore collected every year from natural sources. These collections are always fluctuating in quantity as well as quality and hence are often undependable. The need for a dependable method of pond breeding of these carps ensuring production and supply of quality fish seed has therefore been keenly felt in South-East Asia where these fishes are extensively cultivated.

Since 1957 a successful method of inducing the Indian carps (*C. catla*, *L. rohita*, *C. mrigala* and others) to breed in ponds in response to pituitary hormone injections has been developed in India and millions of fry of these fast-growing carps are now being produced every year by this method.<sup>2-4,7-8,9,10</sup> Though attempts have been made to breed the Chinese carps also in ponds by adopting similar techniques, they have not so far responded positively to the treatment.<sup>5-12,17</sup>

**Chinese Carp in India.**—With a view to find out the possibilities of utilising the Grass carp, *C. idellus*, for controlling rank growth of weeds in fish ponds and enriching the indigenous stock

of cultivable species of fishes with fast-growing exotic forms experimental consignments of *H. molitrix* and *C. idellus* were introduced into India for the first time in 1959.<sup>3</sup> Within the next two years these fishes attained sexual maturity in ponds at Cuttack. During July 1962 experiments on inducing Grass carp and Silver carp to breed in ponds were successfully carried out. Three sets of Silver carps, two sets of Grass carps and a female Bighead yielded viable eggs after receiving pituitary injections. These eggs were fertilized and hatched and the young ones reared in ponds. This, to our knowledge, being the first successful instance of pond breeding of a Chinese carp, a brief resume of our observations is given in this contribution.

**Size Attained.**—Three years' old, mature specimens of these carps ranged in size as shown in Table I.

TABLE I

Specimens	Sex	Length (cm.)	Weight (Kg.)
<i>C. idellus</i>	Male	75.2-86.0	4.54-6.61
	Female	73.8-79.2	4.76-7.03
<i>H. molitrix</i>	Male	62.5-71.0	2.80-4.96
	Female	63.5-81.2	4.99-7.49
<i>A. nobilis</i>	Female	67.2-70.3	4.76-6.00

**Breeding Techniques.**—Mature males of Silver carp and Grass carp were easily distinguished in the field by the marked roughness of the outer surface of the pectoral fins.<sup>15</sup> Freely

oozing males and fully gravid females were selected for injection, usually late in the evening or at night when weather was generally cool with light showers. Pituitary glands for injection were collected from mature fish and were preserved in absolute alcohol. These were extracted in 0.3% saline at the time of injection and the concentration of the extract ranged from 10 to 40 mg. per c.c. The dose to be injected was calculated in mg. per Kg. weight of the breeder; the males always receiving a lower dose than the females. Injections were administered intra-muscularly. Injected fish were released in cloth *hapas* fixed in ponds. Water was stagnant and had the following physico-chemical qualities:

Temperature: 28.2–34° C.; pH: 8.4–8.8; Dissolved Oxygen: 5.37–8.88 p.p.m.; Free CO<sub>2</sub>: nil; Total alkalinity: 102–132 p.p.m.

*Injection.*—Successful doses of injection administered are as in Table II.

6 to 8 hours after the second injection to the female. The breeding *hapas* were periodically examined and as soon as the female started spawning, it was taken out and the oozing eggs were stripped in clean dry enamel trays and immediately mixed with milt pressed out from the injected male. The fertilised eggs were hatched in *hapas* fixed in the pond.

*Stages of Development.*—The fertilised, fully swollen egg measured 1.28 to 1.35/4.2 to 4.76 mm. in diameter in *H. molitrix* and 1.27/4.58 mm. in *C. idellus*. At water temperature ranging from 28 to 31° C. the period of incubation was 18 to 20 hours in both the species. The hatchlings were 4.5 mm. long in *C. idellus* and 4.9 mm. in *H. molitrix*.

*Nursing Fry.*—Two days after hatching the yolk was fully absorbed and the post-larva started feeding from the environment. At this stage (average length: *H. molitrix* — 7.42 mm.;

TABLE II

No.	Date	Hour	Weight of breeders (Kg.)		Donor fish of pituitary gland	Dose administered (Mg./Kg.)				
			Male	Female		Male		Female		
						1st	2nd	1st	2nd	3rd
<i>Hypophthalmichthys molitrix:</i>										
1	9-7-1962	22-00	3.0, 3.9	6.0	<i>H. molitrix</i>	..	..	3.0	..	..
	10-7-1962	05-30	..	..	"	(1) 3.0	..	..	6.0	..
						(2) 4.0	..	..	..	..
2	12-7-1962	20-30	4.6	6.1	"	..	..	3.0	..	..
	13-7-1962	03-30	..	..	"	3.0	..	..	6.0	..
3	15-7-1962	21-00	4.3, 4.5	6.0	"	..	..	3.0	..	..
	16-7-1962	04-00	..	..	"	3.0	..	..	6.0	..
<i>Ctenopharyngodon idellus:</i>										
1	19-7-1962	21-50	5.3	6.8	<i>L. rohita</i>	1.0	..	3.0	..	..
	20-7-1962	04-45	..	..	"	..	3.0	..	6.0	..
2	19-7-1962	22-10	5.1	5.0	"	1.0	..	3.0	..	..
	20-7-1962	04-55	..	..	"	..	3.0	..	6.0	..
<i>Aristichthys nobilis:</i>										
1	21-6-1962	16-00	Silver carp males	6.0	<i>L. rohita</i>	..	..	2.0	..	..
	21-6-1962	22-00	..	..	"	3.0	..	..	5.0	..
	22-6-1962	08-30	"	..	"	..	1.0	..	..	5.0

*Spawning.*—Homoplastic injections as well as injections of pituitary glands collected from Indian carps were administered with success. Thus, while Silver carp females responded to two doses of homoplastic injections amounting to 9 mg. per Kg. weight of the fish, identical doses of Rohu pituitary gland gave similar positive results in Grass carp. The female Big-head required a higher dose to yield viable eggs. Spawning commenced ordinarily about

*C. idellus* — 6.8 mm.) they were released in prepared nursery ponds where the natural food was supplemented by daily artificial feeding with oilcake powder and sieved rice bran.

55,000 fry of *H. molitrix* and 5,000 of *C. idellus* were stocked in three nursery ponds. During the first 15 days of pond rearing survival and growth of fry ranged as shown in Table III.

Thinned out into other nurseries and rearing ponds the fry are rapidly growing and experi-



ments on their growth as compared with that of Indian carps are in progress.

TABLE III

Species	Stocking No. per acre	Rearing period (days)	Percentage of survival	Size attained	
				Length (mm.)	Average wt. (g.)
<i>H. molitrix</i>	3,00,000	9	83.0	19.0-24.0 (22.1)	0.0695
"	2,00,000	9	42.5	22.0-26.0 (24.1)	0.1038
<i>C. idellus</i>	50,000	15	5.0	38.0-52.0 (47.0)	1.50

**Hybridization.**—With the successful breeding of Indian carps by pituitary hormone injections it has been possible to hybridize selected species and produce hybrids with a view to obtaining fish of better cultural qualities.<sup>1-6</sup> In view of their fast growth and other desirable cultural qualities attempts were made to hybridize the Chinese carps with Indian carps and *vice versa*. By injecting gravid specimens of *C. catla* and *L. rohita* simultaneously with *H. molitrix*, *C. idellus* and *A. nobilis* the intergeneric crosses were carried out with partial success as shown in Table IV.

TABLE IV

Male	Female	Result obtained
<i>C. idellus</i> × <i>A. nobilis</i>		Embryos died before hatching
<i>C. idellus</i> × <i>L. rohita</i>		Over 1,00,000 hatchlings produced. Most of them died within a week; one survived for two weeks
<i>H. molitrix</i> × <i>A. nobilis</i>		Embryos died before hatching
<i>H. molitrix</i> × <i>L. rohita</i>		About 1,00,000 hatchlings produced; all died within a week
<i>H. molitrix</i> × <i>C. catla</i>		Hatchlings died on first day
<i>C. catla</i> × <i>C. idellus</i>		"
<i>C. catla</i> × <i>H. molitrix</i>		"
<i>C. catla</i> × <i>A. nobilis</i>		Embryos died before hatching
<i>L. rohita</i> × <i>C. idellus</i>		Hatchlings died on first day
<i>L. rohita</i> × <i>A. nobilis</i>		Embryos died before hatching

Though production of fry or fingerlings could not be achieved during 1962 by the above crosses, the results obtained clearly indicate that it may be possible to produce hybrids of value as we obtain greater experience in the pond breeding of Chinese carps.

**Discussion.**—Pond breeding of fast-growing, large, riverine carps which ordinarily breed only in rivers is an important step in developing fish culture. Methods of successful pond breeding of Indian carps have been developed recently; while the Chinese carps, even though of similar habits, have not been responding to inducements to pond breeding.

Kuronuma<sup>13</sup> mentioned the 'absolute sterility' of Chinese carps in ponds in Japan and Kawamoto's experiments on Grass carp by administering hydrosol of androsteron and enteron mixed with the diet resulted in the maturity of only males in ponds. It may be inferred from Tang<sup>15</sup> that in ponds in Taiwan specimens of *H. molitrix* and *A. nobilis* with fairly well-developed ovaries are found, even though these species do not propagate in that country. According to Yashouv Grass carps attain sexual maturity in ponds in Israel but experiments to induce the species to spawn by injections of carp hypophysis, Pregnil, Gestyl and Yochimbin did not succeed. Russian workers also believe that Grass carp attains sexual maturity in ponds.<sup>17</sup> Experiments at the Tropical Fish Culture Research Institute at Malacca have shown that 2-3 years old specimens of Grass carp mature in the Institute's ponds but continued attempts to induce them to breed by simulating natural conditions by flooding and by injections of Grass carp and Tilapia pituitary glands, Armour ACTH, Cortisone acetate and Actocortin have not met with success.<sup>5</sup> Our own observations now confirm that the common species of Chinese carps like Grass carp, Silver carp and the Bighead attain sexual maturity in ponds, and like the Indian carps, can be induced to breed by administering pituitary hormone injections.

In the Tone river in Japan the Chinese carps spawn when the water temperature ranges from 17.6 to 22° C. in June-July. pH of the water was then only 6.9.<sup>14</sup> Inaba *et al.*<sup>11</sup> record the monthly average temperature in the Tone river as ranging from 5.0° C. in January to 27.7° C. in July. At the Malacca Institute ponds where Grass carp has attained sexual maturity in 2-3 years the water temperature shows a diurnal variation from 28 to 31° C. with the average at about 29.5° C.<sup>10</sup> pH of these waters is reported to be low. The pond waters are distinctly alkaline at Cuttack, where the monthly average temperature in ponds ranged as shown in Table V.

Average water temperature (°C.) in a pond at the Killa farm, Cuttack, during 1961-62

	Jan.	Feb.	Mar.	Apr.	May	June
Average temperature °C. at 12.00 hours	26.6	27.1	33.3	33.6	34.6	31.0
	July	Aug.	Sept.	Oct.	Nov.	Dec.
Average temperature °C. at 12.00 hours	31.3	31.8	31.6	31.9	29.2	25.7

During December-January, water temperature at 6.00 hours would be about 20° C. The maximum water temperature of 39.5° C. is recorded in May. During June-July the average temperature ranges from 25.4 to 33.4° C. It is thus seen that the Chinese carps attain sexual maturity in waters with a wide range of temperature and if the proper dose of hormones are injected could be induced to spawn.

The feasibility of successful hybridisation of Chinese carps with Indian carps and *vice versa* demonstrated in this paper indicates that hybrids of selected desirable qualities could probably be produced in numbers during the ensuing seasons.

Our grateful thanks are due to Dr. B. S. Bhimachar for his keen interest in this work and for his valuable suggestions in the preparation of this paper.

1. Alikunhi, K. H., and Chaudhuri, H., *Proc. 46th Ind. Sci. Cong.*, Delhi, 1959.

2. Alikunhi, K. H., Vijayalakshmanan, M. A. and Ibrahim, H. H., *Ind. Jour. Fish.*, 1960, **7** (1), 1.
3. — and Sukumaran, K. K., *Proc. 49th Ind. Sci. Cong.*, Cuttack, 1962.
4. —, Parameswaran, S. and Sukumaran, K. K., *Ibid.*, 1962.
5. Anon, *Trop. Fish. Cult. Res. Inst., Malacca Repts.*, 1957-61.
6. Chaudhuri, H., *Proc. 46th Ind. Sci. Cong.*, 1959.
7. —, *Ind. Jour. Fish.*, 1960, **7** (1), 20-49.
8. — and Alikunhi, K. H., *Curr. Sci.*, 1957, **26** (12), 381-82.
9. — *et al.*, *Proc. Ind. Sci. Cong.*, Cuttack, 1962.
10. Hickling, C. F., *Malayan Agr. Jour.*, 1960, **43** (1), 49-53.
11. Inaba, D., Nomura, M. and Nakamura, M., *Jour. Tokyo Univ. Fish.*, 1957, **43** (1), 81-96.
12. Kawamoto, N. Y., *Japan Jour. Ichth.*, 1950, **1** (1), 8-16.
13. Kuronuma, K., *Proc. Indo-Pacif. Fish. Comm. Sec. 5th Meeting*, Bangkok, 1954, 126-30.
14. —, *I.P.F.C. Curr. Affairs Bull.* 1958, **22**.
15. Tang, Y., *Taiwan Fish Res. Inst. Fish. Cult. Rep.*, 1954, **1**.
16. Vijayalakshmanan, M. A. *et al.*, *Proc. Ind. Sci. Congr.*, Cuttack, 1962.
17. Yashouv, A., *Bamidgeh*, 1958, **10** (4), 75-80.

### THE H-ALPHA LINE IN THE SOLAR FLARE OF NOVEMBER 12, 1960

THE solar flare, of magnitude 3 +, which occurred on November 12, 1960, gave rise to a series of remarkable solar and associated geophysical events, which have been reported in scientific journals by various observers and study groups. In addition to extensive ionospheric and geomagnetic activities which accompanied the flare, there was also the intense increase in the ground-level solar cosmic ray component which followed within a few minutes after the start of the flare. The flare began at 13<sup>h</sup> 23<sup>m</sup> U.T. and ended at 18<sup>h</sup> 30<sup>m</sup>.

The increase in the ground-level cosmic ray intensity has been interpreted in terms of injection of particles into a "magnetic bottle", which, at the time of the flare, extended from the sun into the immediate vicinity of the earth. This interpretation suggests that the geophysical events subsequent to the flare of November 12, 1960, may have been due only to a fortuitous configuration of magnetic fields in the inner solar system which existed prior to the flare, and not to some special properties of the flare itself. It will therefore be of interest to examine the H-alpha spectra of the flare and to make a comparison of the results with observations of other great flares.

Such a comparison has been made on the H-alpha spectra taken at the McMath-Hulbert Observatory, University of Michigan, and the

results are reported by Richard G. Teske in the *Astrophysical Journal*, 1962, 136, 534. During the progress of the flare which lasted for about  $2 \times 10^4$  seconds, spectra of the H-alpha line were recorded with the vacuum spectrograph of the Observatory, on Super Panchromatic Process emulsion, at a dispersion of 6.0 mm./Å. Exposure times were 90 seconds.

The observed intensity in H-alpha during the premaximum phase and after flare maximum was comparable with, or less than, that generally observed in importance 3 + flares. The data do not show that the flare of November 12, 1960, departed in anyway from values of H-alpha width and central intensity, excitation temperature, optical thickness, and rate of radiation in the H-alpha line, that have already been obtained by others of importance 3 + flares.

Material recovered from the artificial satellite, EXPLORER XVII, which was exposed while in circumterrestrial orbit to bombardment by particles from the November 12 flare was found to contain a high concentration of tritium (reported 1961), which was attributed as having emanated from the flare itself. Search in the spectrogram for deuterium, which is also a product of the tritium producing process, showed no evidence of deuterium.—(*Astroph. Jour.*, 1962, 136, 534.)

## LETTERS TO THE EDITOR

### LIFETIME OF THE 70 KEV. LEVEL IN $\text{Sb}^{121}$

We have determined the lifetime of the 70-Kev level in  $\text{Sb}^{121}$  by means of the delayed coincidence technique. The level was formed by the 506 Kev. transition following the decay of 17-day  $\text{Te}^{121}$  produced by  $(p, n)$  reaction on natural antimony. The gamma-rays were detected in  $1'' \times 2''$  NaI counters. The measured value of the lifetime is  $(8 \pm 1.5)$  ns, the main uncertainty in the result being due to calibration difficulties. The equipment was calibrated by studying the lifetime of the 80-Kev level in  $\text{Cs}^{133}$  following the decay of  $\text{Ba}^{133}$ . Delayed coincidence measurements on the 358-80 Kev.  $\gamma$ -cascade yielded a half life of  $(6 \pm 0.7)$  ns for the 80 Kev. level.

From our lifetime measurements and gamma-gamma coincidence data in the decay of  $\text{Te}^{121}$ , we confirm the level ordering in  $\text{Sb}^{121}$  recently proposed by Gupta,<sup>1</sup> namely levels at 70, and 576 and 1200 Kev. The lifetime of the 576 Kev level was found to be less than 1 ns by comparison with annihilation photons.

The spin of  $\text{Sb}^{121}$  has been measured<sup>2</sup> to be  $5/2$  and the parity is presumably even from magnetic moment data.<sup>3</sup> If it is assumed from systematics of excited levels in this region, that the 70 Kev level is  $7/2 +$ , then according to the shell-model this is possibly a  $g_{7/2}$  state and the ground state a  $d_{5/2}$  level. Thus one would expect that the 70 Kev. transition is  $l$ -forbidden ( $\Delta l = 2$ )  $M1$  transition with perhaps  $E2$  admixture. Unfortunately, neither the conversion coefficient nor the mixing ratio for this transition is known. If we then assume that the transition is pure  $M_1$ , the measured lifetime, by comparison with the single particle estimate, yields a retardation factor of about 360. While this number is in keeping with other  $l$ -forbidden  $M1$  transitions, it would have been important to find the  $E_2$  enhancement. A recent analysis<sup>4</sup> has shown large enhancements in  $l$ -forbidden transitions indicating a collective type of behaviour.

The author wishes to thank the hospitality of Prof. P. S. Jastram of Ohio State University.

Dept. of Physics, M. K. RAMASWAMY.  
Karnatak University,  
Dharwar-3, November 27, 1962.

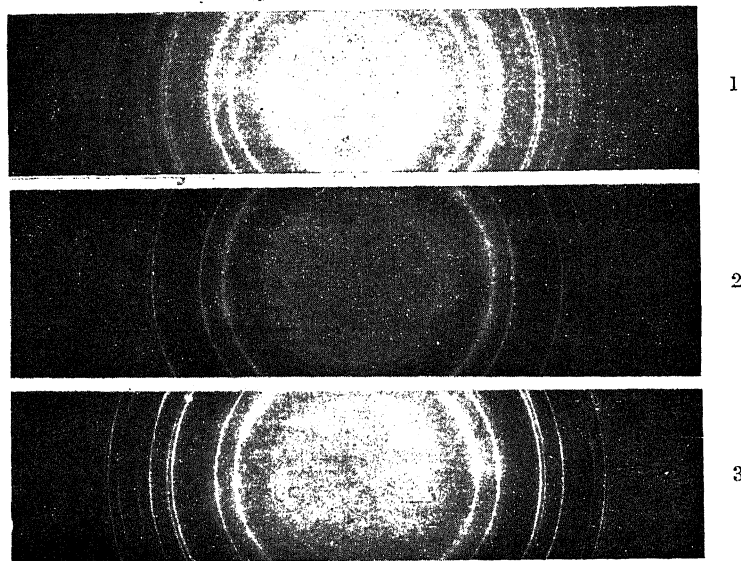
1. Gupta, R. K., *Nuovo Cimento*, 1960, 17, 665.
2. See for instance Strominger, D.: in *Nuclear Spectroscopy*, Ed. F. Ajenberg-Selove, Academic Press, 1960.
3. See for instance: Frauenfelder in *Nuclear Spectroscopy*, Ed. F. Ajenberg-Selove, Academic Press, 1960.
4. Ramaswamy, M. K., *Proc. Rutherford Jubilee International Conference*, 1961.

### OBSERVATIONS ON ORIENTED CRYSTAL GROWTH IN ALUMINIUM FILMS ON TWO ALKALI HALIDE SUBSTRATES

SEVERAL workers<sup>1-6</sup> have examined the face-centred cubic metals by transmission electron diffraction. Finch, Querrell and Wilman<sup>1</sup> were among the first to examine the thinned commercial foils of aluminium by transmission electron diffraction and reported the presence of random crystals in them. They also observed oriented crystal growth in heated foils of aluminium. Later, Bruck<sup>2</sup> studied evaporated thin films of aluminium and several other metals formed over rock salt maintained at room temperature and also at elevated temperatures. He has reported orientation of crystals in aluminium thin films formed on heated rock salt. Recently, Bahadur and Sastry<sup>7</sup> studied thin films of aluminium evaporated on rock salt in vacuum (at room temperature and also at elevated temperatures) and showed that the films were only polycrystalline.

To try to resolve the conflicting experimental evidence regarding the mode of crystal growth in the film, the author did the following experiments:

Thin films were evaporated in vacuum simultaneously over freshly cloven rock salt and potassium chloride single crystal substrates at room temperature. The transmission electron diffraction patterns of these films revealed only polycrystalline growth (Fig. 1). Next the films were formed over the same substrates but maintained at  $300^\circ \text{C}$ . The films so formed were subsequently annealed inside the coating unit (without breaking the vacuum) at  $300^\circ \text{C}$ . for  $1\frac{1}{2}$  hours and were then cooled to room temperature. The following significant results were obtained;



FIGS. 1-3. Fig. 1. Diffraction pattern of aluminium film formed over rock salt and potassium chloride crystal at room temperature. Fig. 2. Diffraction pattern of aluminium film formed over heated rock salt showing oriented crystal growth when examined after forty-eight hours. Fig. 3. Diffraction pattern of aluminium film formed over heated potassium chloride crystal showing oriented crystal growth soon after formation.

1. The films grown on heated rock salt did not show oriented crystal growth when examined soon after growth. This observation matches that observed earlier.<sup>7</sup> However, when these films were aged for forty-eight hours at room temperature on the substrate, oriented crystal growth showed up (Fig. 2).

2. Films grown on heated potassium chloride crystal showed oriented crystal growth straight away. No ageing of the film was necessary (Fig. 3).

The author wishes to thank Dr. W. M. Vaidya and Dr. R. Parshad for encouragement in the work and to Shri G. L. Malhotra for technical help. Thanks are also due to CSIR for the award of a Research Fellowship which made this work possible.

Electronics Division,  
National Physical

S. K. SHARMA.

Laboratory of India,  
New Delhi-12, January 5, 1963.

### PULSE-SINE WAVE CONVERTER

In some work in musical acoustics, that is going on in this Laboratory, it was necessary to convert sharp pulses into sine waves. The total range of repetition rate of these pulses to be converted was about two octave. The only two circuits that seem to be available for this purpose are those given by Cameron (*Electronics*, March 1949) and Brunner (*Electronics*, December, 1952).

Both these circuits have their own limitations. The amplitude of sine waves in Cameron's circuit arrangement decreases rapidly as the frequency rises. The second circuit is very much complicated and is equally unsuitable. The following arrangement using Philips Decade Counter Tube E.I.T., however, was found to be quite successful and simple.

Philips Decade Counter Tube E.I.T. has a characteristic as shown in Fig. 1, where the anode current  $I_{a_2}$  is plotted as a function of the right-hand deflection electrode voltage  $V_{D_1}$ , the left-hand deflection electrode voltage  $V_{D_2}$  remaining constant at 156 Volts (*Philips Electronic Application Bulletin*, subject—E.I.T. Decade Counter Tube, page 5). The connections to the other electrodes of the tube are shown in Fig. 2. It will be seen that these connections are the same as given in that bulletin (page 8) except for the fact that the right-hand deflecting plate

1. Finch, G. I., Querrell, A. G. and Wilman, H., *Trans. Faraday Soc.*, 1935, **31**, 1051.
2. Bruck, V. L., *Ann. Phys.*, 1936, **26**, 233.
3. Querrell, A. G., *Proc. Phys. Soc.*, 1937, **49 A**, 229.
4. Goche, O. and Wilman, H., *Proc. Phys. Soc.*, 1939, **51**, 625.
5. Nimura, H., *J. Phys. Soc. Japan*, 1955, **19**, 642.
6. Rymer, T. B., *Proc. Roy. Soc.*, 1956, **235 A**, 274.
7. Bahadur, K. and Sastry, P. V., *Proc. Phys. Soc.*, 1961, **78**, 594.

D' is disconnected from the anode load resistance of one megohm and is given a biasing voltage of 104 Volts and the valve therefore is working on the point E of its characteristics.

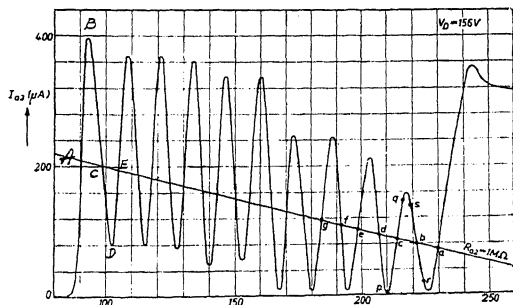


FIG. 1

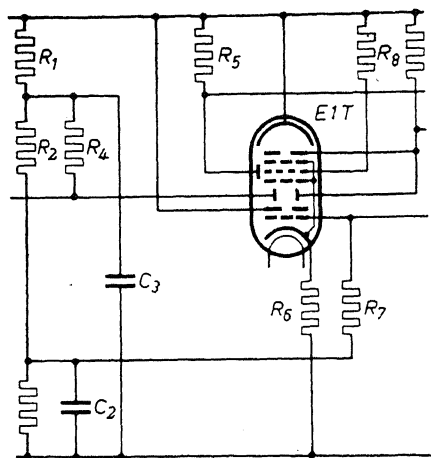


FIG. 2

If now the voltage of D' is varied between 104 and 90 Volts at a uniform rate with an instantaneous fly back, the output from the second anode  $a_2$  would be as shown by the portion E D C B A of the characteristics which is for all practical purposes a sine wave.

This is therefore utilised in the following manner to convert pulses into sine waves.

The sharp input pulses actuate a flip-flop circuit giving rectangular pulses of constant amplitude. The condenser  $C_0$  is allowed to be charged and discharged through the rectifier 6H6 as in Lott's direct reading frequency-meter. The negative voltage developed across  $R_1$  is therefore proportional to the repetition frequency of the incoming pulses. This voltage is given to grid of the pentode amplifier 6SJ7. The tap S on the resistance  $R_1$  and the plate

resistance  $R_2$  of this valve are adjusted so that the output voltage at the anode P is directly proportional to the grid voltage and hence to the repetition frequency of the incoming pulses for about 2 octaves.

In the actual circuit used in this Laboratory the voltage at P varied from 75 to 303 Volts. (This arrangement has to be carefully adjusted for each individual valve.)

The valve  $V_3$  is a triggered Miller integrator saw-tooth generator in which the charging condenser through the resistance  $R_3$  is connected to the variable voltage at P and biggier pulses and applied to the anode as usual. The slope of the saw-tooth run-down is thus governed by the potential at P and thus by the repetition frequency of the incoming pulses.

In spite of the frequency variation, the run-down is thus automatically complete and has a constant amplitude. The output of this saw-tooth generator is taken from the cathode follower  $V_4$  and the amplitude is adjusted to about 14 Volts by the tap on the cathode resistance  $R_4$  of the cathode follower.

This saw-tooth voltage is superimposed on the steady biasing voltage of the right-hand deflecting electrode D' of the counter tube as shown in Fig. 3.

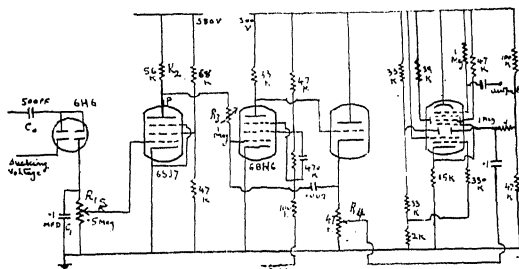


FIG. 3

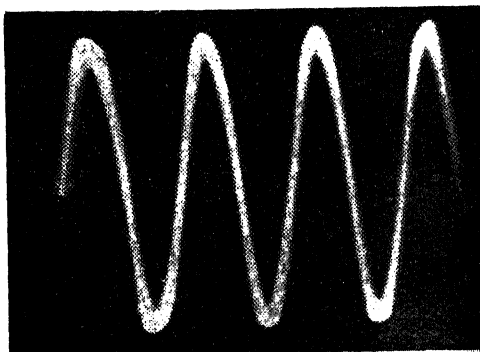


FIG. 4

Consequently we get at the anode  $a_2$  of the counter tube an almost sine wave output of constant amplitude in spite of the changes in the repetition frequency of the incoming pulses (Fig. 4).

Physics Laboratory,  
Ruparel College, Bombay-16,  
January 19, 1962.

B. B. DESHPANDE.

### ADIABATIC COMPRESSIBILITY OF AQUEOUS SOLUTIONS OF LITHIUM NITRATE

It has been observed by the author<sup>1</sup> that in spite of the high charge density of  $\text{Li}^+$  ion, lithium halides lower the compressibility of water to a smaller extent than other alkali halides. This behaviour has been explained as due to the structural changes brought out by the polarisation produced in water by the lithium ion. On the basis of this explanation, we should expect other simple lithium salts also to behave in a similar way. In the present investigation, compressibility behaviour of aqueous solutions of lithium nitrate has been studied with a view to compare it with that of sodium and potassium nitrates. To facilitate comparison, even though data are available in the literature,<sup>2,3</sup> sodium and potassium nitrates have been studied at the same temperature.

Ultrasonic velocity  $V$  is determined using a single crystal interferometer working at 720 kc./sec. Densities are measured by the hydrostatic method. Adiabatic compressibility  $\beta$  is evaluated with the above data with a probable error of  $\pm 0.2\%$ .

The variation of  $\beta$  ( $\text{atmos}^{-1}$ ) with molar concentration  $C$  (moles/litre) for aqueous solutions of lithium, sodium and potassium nitrates is shown in Fig. 1. On the basis of simple coulomb forces the lowering of compressibility of water at any concentration should increase in the order  $\text{LiNO}_3 > \text{NaNO}_3 > \text{KNO}_3$ . Sodium and potassium nitrates conform to this order while the compressibility lowering is small in the case of lithium nitrate. Data from the work of Marks indicate that lithium hydroxide<sup>4</sup> and lithium sulphate<sup>5</sup> also exhibit a similar behaviour when compared with the corresponding sodium and potassium salts.

If the anomalous behaviour of lithium salts is due to structural changes of water, we should expect normal behaviour in non-aqueous media. Experimental studies on the behaviour of some alkali bromides and nitrates in non-aqueous media are in progress and preliminary results

indicate normal behaviour of lithium nitrate in glycol solutions.

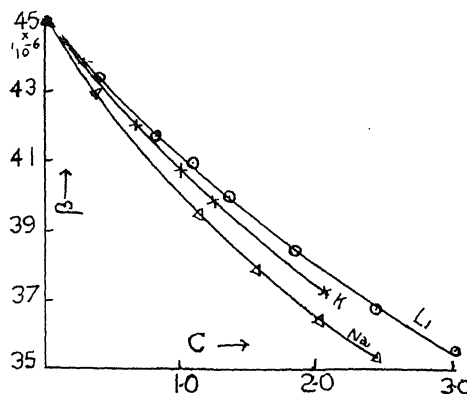


FIG. 1. Variation of adiabatic compressibility with molar concentration for aqueous solutions of alkali nitrates at  $27^\circ\text{C}$ .

The apparent molar compressibility of  $\text{LiNO}_3$  conforms to the relation  $\phi(K_2) = -36 + 9C^{3/2}$ . Hydration number for  $\text{LiNO}_3$  evaluated from the value of apparent molar compressibility at infinite dilution works out as 4.3 while the value obtained from activity data<sup>7</sup> is 3.4.

The variation of  $V^{2/3}/\rho$  with percentage weight of  $\text{LiNO}_3$  in aqueous solutions is found to be linear. The linear plot is used to evaluate the molar sound velocity of  $\text{LiNO}_3$  in the liquid phase by the procedure suggested by the author in a previous communication.<sup>8</sup> The value so obtained 6.0 (M.K.S. units) is in satisfactory agreement with the value of 5.63 obtained from the data on melts.<sup>8</sup>

The author takes this opportunity to thank the Ministry of Scientific and Industrial Research, Government of India, for financial assistance to this scheme. His thanks are also due to Dr. J. Bhimasenachar for his valuable suggestions and encouragement.

Physics Department, S. V. SUBRAHMANYAM.  
Sri Venkateswara University,  
Tirupati (India), January 22, 1963.

1. Subrahmanyam, S. V., *Acoustica* (under publication).
2. Prosserow, P., *J. fur. phys. chemie* (U.S.S.R.), 1940, **14**, 384.
3. Subrahmanyam, S. V. and Bhimasenachar, J., *J. Acoust. Soc. Am.*, 1960, **32**, 835.
4. Marks, G. W., *Ibid.*, 1960, **32**, 835.
5. —, *Ibid.*, 1959, **31**, 936.
6. Wada, Y., Shimbo, S. and Oda, M., *Ibid.*, 1950, **22**, 880.
7. Glueckauf, E., *Trans. Faraday Soc.*, 1955, **51**, 1235.
8. Subrahmanyam, S. V. and Bhimasenachar, J., *J. Phys. soc., Japan*, 1961, **16**, 1447.

THE RESOLUTION OF  
(±) BUTANE-2-OL  
(METHYL-ETHYL CARBINOL)

OPTICALLY pure (+) butane-2-ol was first prepared by Pickard and Kenyon<sup>1</sup> by fractional crystallisation of the brucine salt of the (±) hydrogen phthalate but they did not obtain (−) brucine salt of (−) hydrogen phthalate in crystalline form from the mother liquor of the more soluble brucine salt. Pickard and Kenyon converted (−) and (±) butanol, obtained from the more soluble brucine salt into its liquid hydrogen succinic ester. The cinchonidine salt of this ester after five crystallisations from acetone—in which it is very soluble—yielded the (−) ester which on hydrolysis gave optically pure (−) butane-2-ol.  $\alpha_D^{25} - 13.8$ ;  $[\eta] + 13.1$ .

Some twenty years later Viditz<sup>2</sup> obtained the crystalline brucine salt of the (−) hydrogen phthalate, m.p. 119–21°, from the mother liquor of the more soluble brucine salt. He could not purify it further by crystallisation from any solvent because the salt did not separate out from its solution in acetone, alcohol, or chloroform.

In the present work (+) and (−) butane-2-ol have been obtained in optically pure condition ( $\alpha_D^{25} + 13.86$ ;  $[\eta] - 13.1$ ) from the respective brucine salts by the hydrolysis of (+) and (−) hydrogen phthalic esters, m.p. 56–57°. Pickard and Kenyon have recorded the melting point of (+) hydrogen phthalate 46–47° (solidified on porous tile) but they did not obtain (−) hydrogen phthalate in solid state.

The melting point of (−) hydrogen phthalate has not been mentioned in literature by later workers; probably they could not obtain it in crystalline form.

EXPERIMENTAL

**Preparation of (±) -2-butyl hydrogen phthalate.**—A mixture of 2-butanol (148 g.; 2 mol.) phthalic anhydride (296 g.; 2 mol.), triethylamine (100 g.; 1 mol.) and dioxane (50 g.; 1 mol.) was kept at 60–70° for an hour and the resulting clear liquid cooled and acidified with dilute hydrochloric acid (1:1) mixed with ice. The viscous layer of hydrogen phthalate was dissolved in ether, thoroughly washed with water and dried ( $\text{Na}_2\text{SO}_4$ ) and the solvent removed when the residue (m.p. 54–56°) was recrystallised from ether and light petroleum to yield octahedral crystals, m.p. 56–57°; yield 355 g.; 80% Pickard and Kenyon<sup>1</sup> gave m.p. 56–57°.

**Preparation of (+)-2-butyl hydrogen phthalate.**—(+)-2-Butyl hydrogen phthalate, m.p. 56–57°;  $\alpha_D^{25} + 38.6$ ° (1, 1, alc) was obtained in 90% yield from the less soluble brucine salt, m.p. 155–57°, by Pickard and Kenyon's<sup>1</sup> method.

**(−)-2-Butyl hydrogen phthalate.**—The filtrate from which the less soluble brucine salt has been removed was concentrated to a small bulk and seeded with less soluble brucine salt. This on leaving for a week began to deposit the brucine salt of the (−) hydrogen phthalate. This steadily increased until almost the whole separated out. It had m.p. 119–21°; it was recrystallised twice from acetone (in which it is very soluble) containing a few drops of petroleum ether, b.p. 60–80° and finally from methanol to yield rhombic crystals, m.p. 156°; yield 257 g. (83%).

From it was obtained the (−) hydrogen phthalate by acidification with ice-cold dilute hydrochloric acid until the precipitation of the oily (−) hydrogen phthalic ester was complete. After decantation of the aqueous layer (from which brucine was recovered) the oily (−) hydrogen phthalate was washed with water, dissolved in ether, and the ether solution dried ( $\text{Na}_2\text{SO}_4$ ). Ether was recovered and the oily hydrogen phthalate solidified by removing the last traces of the solvent by passing air through it and then purified by recrystallisation from ether and light petroleum, m.p. 56–57°; yield 65 g. (77%)  $\alpha_D^{25} - 35.5$  (1, 1, EtoH).

**(+) and (−) butane-2-ol.**—(+) and (−) butane-2-ol (b.p. 99–99.5°/760 mm.;  $D_{20} 1.3954$ ;  $\alpha_D^{25} + 13.1$ ,  $[\eta] - 13.1 - l_1$ ) were obtained from their respective hydrogen phthalates by hydrolysis with aqueous solution of caustic soda (2½ mol.) followed by steam distillation.

(This work has been carried out in the Chemistry Department, Battersea College of Technology, London, S.W. 11.)

Chemistry Department,  
College of Engineering  
and Technology,  
New Delhi-16,  
December 21, 1962.

J. L. NORULA.  
J. KENYON.

1. Pickard and Kenyon, 1911, 99, 45.
2. Viditz, *Biochem. Z.*, 1933, 259, 294; *Chem. Abs* 1933, 27, 2671.

# THE HYDROGEN BONDING ENERGIES FROM NEAR ULTRA-VIOLET ABSORPTION SPECTRA IN *p*-BROMOPHENOL AND *o*-HYDROXY BIPHENYL

WHEN the absorption band of a hydrogen-bonded molecule is appreciably different from that of the free molecule, the equilibrium constant ( $K$ ) between the proton acceptor and the proton donor in an inert solvent can often be determined by measuring the absorbance values of three solutions.<sup>1</sup> It is necessary that the proton donor concentration is the same in the different solutions though different proton acceptor concentrations are permissible. The absorbance values refer to a fixed wavelength, at a constant temperature.

Now the free energy change in a reaction is given by the well-known relation :

$$\Delta G = -RT \ln K.$$

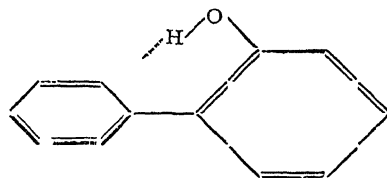
The equilibrium constant can be estimated from the absorbance by the equation :

$$K = \frac{C_A(a_0 - a') + C_A'(a - a_0)}{C_A C_A'(a' - a)}$$

where  $a_0$ ,  $a$  and  $a'$  are absorbance values corresponding to the proton acceptor concentrations,  $C_0$ ,  $C_A$  and  $C_A'$ .

well with a value for phenol and *p*-chlorophenol under similar circumstances.<sup>1</sup>

The calculated  $\Delta H$  value for *o*-hydroxy biphenyl is too low. This is perhaps due to a resistance to an intermolecular hydrogen bond formation between the oxygen of the molecule and that of the acceptor. An intramolecular hydrogen bond has been suspected to be present in the molecule of *o*-hydroxy biphenyl as a result of dipole moment studies.<sup>2</sup> The indication is that the molecule may have a structure as follows :



Department of Chemistry,  
Madras Christian College,  
Tambaram, January, 4, 1963.

T. DEVANATHAN.

1. Nagakura, *J. Amer. Chem. Soc.*, 1954, **76**, 3070.
2. Devanathan, T., *Proc. Ind. Acad. Sci.*, 1963, **57A**, 25.

TABLE I

System	Temperature °C.	$C_A$ mole/litre	$C_A'$ mole/litre	$\lambda$ (m $\mu$ )	$K$	$\Delta G$ kcal/mole	$\Delta H$ kcal/mole
1. <i>p</i> -Bromophenol ethyl acetate	35	0.07994	0.4033	284	29.16	-2.07	} -3.90
	55	0.07994	0.4033	284	20.09	-1.96	
2. <i>o</i> -Hydroxy biphenyl- ethyl acetate	45	0.1212	0.3231	284	2.98	-0.69	} -0.84
	55	0.1212	0.3231	284	2.06	-0.47	
	65	0.1212	0.3231	284	1.36	-0.21	

*p*-Bromophenol and *o*-hydroxy biphenyl have been used as proton donors and ethyl acetate as acceptor. The solvent was *n*-heptane, and the spectral region between 200 and 300 m $\mu$ . was studied in a Beckman DU spectrophotometer. A clear increase in the intensities of absorption was noted in both systems, and in the *p*-bromophenol-ethyl acetate system there was an appreciable 'red shift' in the  $\lambda_{\max}$ .

Table 1 records the various data required for the estimation of the values for  $K$  and  $\Delta G$ ; a plot of  $R \ln K$  against  $1/T$  led to a straight line, the slope of which represents the hydrogen bonding energy ( $\Delta H$ ). Table I also records the  $\Delta H$  values.

The hydrogen bonding energy for the *p*-bromophenol-ethyl acetate system compares

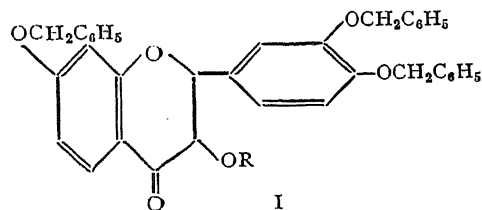
## SYNTHESIS OF ( $\pm$ ) FUSTIN AND ITS DERIVATIVES

FUSTIN-7, 3', 4'-trihydroxydihydroflavonol was isolated from *Rhus succedanea* by Oyamada.<sup>1</sup> Its trimethyl ether was synthesised.<sup>1,2</sup> The synthesis of fustin, which has not been reported so far, is described in the present communication.

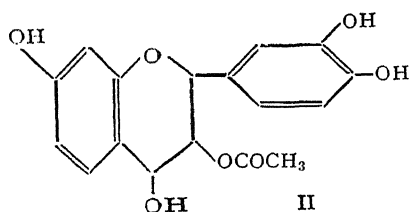
It was observed in this laboratory that dihydroflavonolacetates<sup>3</sup> could be stereospecifically reduced over Raney Nickel to the corresponding 3-acetoxyflavan-4-ols, while reduction of dihydroflavonols<sup>4</sup> with the same catalyst gave a mixture of flavandiols isomeric in position '4'.



With a view to synthesise mollisacacidin<sup>5</sup> stereospecifically, 7, 3', 4'-tribenzyloxydihydroflavonolacetate<sup>6</sup> (I) m.p. 136° was hydrogenated over Raney Nickel. Instead of getting 7, 3', 4'-trihydroxy-3-acetoxyflavan-4-ol (II), 7, 3', 4'-trihydroxydihydroflavanol-3-acetate (III) m.p. 219-221° (decomp.) (Found: C, 59.9%; H, 4.4%. Calc. for  $C_{17}H_{14}O_7 \cdot \frac{1}{2}H_2O$ : C, 60.16%; H, 4.4%;  $H_2O$ , 2.4%. Calc. for  $C_{17}H_{14}O_7 \cdot \frac{1}{2}H_2O$ :  $H_2O$ , 2.65%) was obtained. A similar observation was made by Freudenberg,<sup>7</sup> who isolated taxifolin-3-acetate on hydrogenation of tetrabenzyloxytaxifolin-3-acetate with palladium over barium sulphate. Further, the trihydroxydihydroflavonol-3-acetate was characterised by preparing its triacetate-7, 3', 4'-triaceoxydihydroflavonol-3-acetate (III a), m.p. 1.8 142-143°. (Found: C, 60.3%; H, 4.6%; Calc. for  $C_{23}H_{20}O_{10}$ : C, 60.5%; H, 4.4%) and its tribenzoate-7, 3', 4'-tribenzoyloxydihydroflavanol-3-acetate (III b), m.p. 159-160°. (Found: C, 71.2%; H, 4.2%. Calc. for  $C_{38}H_{26}O_{10}$ : C, 71.0%; H, 4.0%.)

I, R = -COCH<sub>3</sub>.

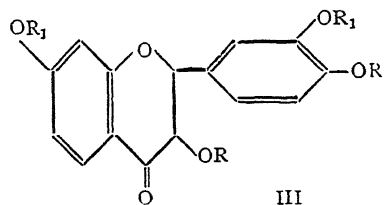
III a, R = H.



The above rather unexpected observation, that the methyl ethers of dihydroflavonol-3-acetates got reduced to 3-acetoxyflavan-4-ols over Raney Nickel while the benzyl ether of dihydroflavonol-3-acetate (I) gave only the trihydroxydihydroflavonolacetate (III), suggested a method for the synthesis of hydroxydihydroflavonols. This

method is used and the synthesis of fustin is achieved. 7, 3', 4'-Tribenzyloxydihydroflavonol,<sup>6</sup> m.p. 160° (Ia), was reduced over Raney Nickel and fustin (III c), m.p. 226-228° (decomp.) (Found: C, 62.6%; H, 4.6%. Calc. for  $C_{15}H_{12}O_6$ : C, 62.5%; H, 4.2%) was isolated. The melting point of synthetic fustin was not depressed on admixture with the natural sample kindly sent by Dr. Weinges to whom we are grateful. Synthetic fustin was characterised by preparing its tetraacetate, which showed no depression on mixed melting point with the tetraacetate (III a), reported above. Synthetic fustin gave all colour reactions<sup>1</sup> given by fustin isolated from nature. Chemistry Department, N. H. KAMKHALIA. Institute of Science, A. B. KULKARNI. Bombay-1, January 22, 1963.

1. Oyamada, T., *Liebigs. Ann.*, 1939, **538**, 66.
2. Shah, V. R., Joshi, C. G. and Kulkarni, A. B., *Chem. and Ind.*, 1955, 1062.
3. Phatak, D. M., and Kulkarni, A. B., *Curr. Sci.*, 1959, **28**, 328 and 1961, **30**, 101.

III, R = -COCH<sub>3</sub>, R<sub>1</sub> = H.III a, R = R<sub>1</sub> = -COCH<sub>3</sub>.III b, R = -COCH<sub>3</sub>.R<sub>1</sub> = -COC<sub>6</sub>H<sub>5</sub>.III c, R = R<sub>1</sub> = H.

4. Kashikar, M. D., and Kulkarni, A. B., *J. Sci. and Ind. Res.*, 1959, **18 B**, 418.
5. Keppler, H. H., *Chem. and Ind.*, 1956, 380 and *J. Chem. Soc.*, 1957, 2722.
6. Mulchandani, N. B. and Kulkarni, A. B. *J. Sci. and Ind. Res.*, 1960, **19 B**, 59.
7. Freudenberg, K., and Weinges, K., *Liebigs. Ann.*, 1958, **613**, 61.
8. Weinges, K., *Ibid.*, 1959, **627**, 234

# WATER-SOLUBLE ALKALOIDS OF THE ROOT BARK OF *CISSAMPELOS* *PAIREIRA* "LINN."

CHLOROFORM-SOLUBLE alkaloids obtained from the root bark of *Cissampelos pareira* "Linn.", family Menispermaceae, have been the subject of extensive investigation. This plant grows wild in India and has since long found use in medicine as an astringent and diuretic and for the cure of diseases such as diarrhoea, fever and heart trouble.<sup>1</sup> The alkaloids isolated so far are *l*-Bebeerine,<sup>2</sup> Hayatin,<sup>3</sup> Hayatinin,<sup>4</sup> and *d*-Isochondrodendrine.<sup>5</sup> Their pharmacological activities as well as partial or full constitution have also been studied.

Kupchan and coworkers<sup>6</sup> for the first time reported that the aqueous residue left after chloroform extraction still contained a good amount of quaternary ammonium compounds. They isolated them in the form of a mixture of chlorides and showed that they produced marked arterial depression.

The detection of four new alkaloids in an aqueous extract of the root bark and the isolation of three of them in a pure form is now reported.

An aqueous extract of the root bark was shaken up repeatedly with chloroform after adjusting to pH 8 and 12. These chloroform extracts showed the presence of already known alkaloids, *l*-Bebeerine, Hayatin, Hayatinin and *d*-Isochondrodendrine on plate by thin layer chromatography with Kieselgel-G<sup>7</sup> in the system chloroform: methanol (90 : 10) after exposing the plate to ammonia vapour for 5 minutes. The Dragendorff's reagent has been used as sprayer. They were, therefore, not subjected to further investigations. The aqueous layer was acidified with HCl to pH 2 and the residual alkaloids were then precipitated as the Reineckates.<sup>8</sup> The solid material was collected and extracted with acetone. Treatment of the acetone extract with silver sulphate and barium chloride solution<sup>9</sup> yielded an aqueous solution of the chlorides of the water-soluble alkaloids.

Descending paper chromatography of a small portion of the solution using methylethyl-ketone: ether (5:1) saturated with 1% aqueous hydrochloric acid as the solvent system and Dragendorff's reagent as the sprayer revealed four new spots. These were distinct from *l*-Bebeerine, Hayatin and Hayatinin,\* whose chlorides remained at the starting-point without migrating. These spots have been provisionally termed

A, B, C and D. Their  $R_f$  values with reference to substance B are 1.70, 0.54 and 0.28 respectively. The  $R_f$  values could not be given because the proper resolution occurred in about eight hours when the solvent front was allowed to run out.

The rest of the original mixture of chlorides was then chromatographed on a cellulose column with the above solvent system, whereupon substances A, B and C were obtained in pure form, as established by paper chromatography. All the fractions containing substance D were found to be admixed with substance C; so far, it has not been possible to obtain substance D in pure form.

Substance A and its picrate have been obtained in an amorphous state; efforts to crystallise them have not met with success. Substance B crystallised from methanol-ether as colourless rhombic granules, m.p. 205–207° C. Its colour tests with conc. sulphuric acid (violet) and conc. nitric acid (orange) are different from those of *l*-Bebeerine, Hayatin and Hayatinin. The picrate of substance B crystallised from acetone-ether melted at 157–158° C. Substance C also failed to crystallise out, but was characterised as its picrate, which crystallised from methyl-ethyl ketone and melted at 169–171° C.

One of us (R.M.S.) is grateful to the Council of Scientific and Industrial Research, New Delhi, for the award of a Fellowship.

Department of Chemistry, R. M. SRIVASTAVA.  
Lucknow University, M. P. KHARE.  
Lucknow, U.P.,  
September 15, 1962.

1. Chopra, R. N., Chopra, I. C., Handa, K. L., and Kapur, L. D., *Indigenous Drugs of India*, 2nd Ed., V. N. Dhur and Sons, Calcutta, India, 1958.
2. Wiggers, A., *Annalen*, 1840, **33**, 81; Scholtz, M., *Ber.*, 1896, **29**, 2054.
3. Bhattacharji, S., Sharma, V. N. and Dhar, M. L., *J. Sci. Ind. Res.*, 1952, **11B**, 81.
4. —, *Bull. Natl. Inst. Sci. India*, 1955, **4**, 39.
5. Prof. Tomita, M., *Vide Reference* (6).
6. Kupchan, S. M., Yokoyama, N. and Beal, J. L., *J. Amer. Pharm. Assn.*, 1960, **49** (11), 727.
7. Stahl, E., *Angew. Chim.*, 1961, **73**, 646.
8. Panouse, J. J., *Bull. Soc. Chem. France*, 1949, 594.
9. Kapfhammer, J., Bischoff, C., *Z. Physiol. Chem.*, 1930, **191**, 182.

\* The authors thank Dr. S. Bhattacharji, Central Drug Research Institute, Lucknow, India, for authentic samples of *l*-Bebeerine, Hayatin, Hayatinin and *d*-Isochondrodendrine.

# CHEMICAL EXAMINATION OF THE FLOWERS OF *LANNEA COROMANDELICA*

*Lannea coromandelica* (Houtt.) Merrill<sup>1,2</sup> (Syn. *L. grandis* Engl., *Odina wodier* Roxb.—Anacardiaceae) is a large tree commonly found all over India and its astringent bark is frequently used in indigenous system of medicine, as an application to wounds, obstinate ulcers and eye-sores, and in gout. According to an earlier report,<sup>2</sup> the bark contains about 8% of phlobatannin but no other chemical components responsible for its medicinal properties have been mentioned. The small flowers of this plant are found in compact clusters (cymose fascicles) with an attractive yellow colour, particularly on the trees when they are bare of leaves. The results of our chemical examination of the flowers and a preliminary study of the stem bark are given in this communication.

The withered flowers, collected in the mornings during April 1962, were extracted three times with methanol by cold maceration lasting for 24 hours and the combined extracts concentrated *in vacuo* to remove almost all the solvent. The aqueous alcoholic concentrate was shaken with petroleum ether, ether and ethyl acetate in succession. The residue from the petroleum ether layer contained large amount of wax and chlorophyll. The ether layer was yellow in colour and gave strongly positive colour reactions for anthoxanthin pigments, which were indicated to be quercetin and morin by paper chromatography. Hence, the residue from the ether concentrate was treated with hot benzene to remove some green pigment and the benzene insoluble portion was taken up in acetone. From the acetone solution, quercetin (identified through its acetate, m.p. 195–96° and comparison with an authentic sample) could be isolated in a pure condition (yield 0.1%). The acetone mother liquor contained small quantities of morin which could be identified by its characteristic colour reactions and paper chromatography.<sup>3,4</sup> The presence of morin was confirmed by comparison and co-chromatography with an authentic sample. The acetone mother liquor also gave a strongly positive Griessmayer-Reichelsche reaction<sup>5</sup> for ellagic acid.

The ethyl acetate layer on concentration and keeping in an ice-chest deposited some pale yellow solid (yield 0.4%) which on recrystallization from dry ethyl acetate came out as almost colourless needles melting above 360°. It was identified as ellagic acid by its fluorescence under

u.v. light on paper chromatography, characteristic colour reactions (alcoholic ferric chloride—green; aqueous sod. hydroxide—bright yellow; sodium nitrite and glacial acetic acid—transient yellow changing to violet and reddish-brown) and by preparing its tetra-acetate, m.p. 340–42° with no depression in m.p. on admixture with an authentic sample of ellagic acid tetra-acetate.<sup>6</sup> The substance on methylation (dimethyl sulphate and anhydrous potassium carbonate in acetone medium for 40 hr.) yielded an almost colourless methyl derivative, m.p. 338–40° agreeing with tetra-O-methyl ellagic acid.<sup>7</sup>

The aqueous alcoholic solution after extraction with ethyl acetate gave positive reaction for a 3-glycoside which was shown to be isoquercitrin by comparison and co-chromatography with an authentic sample of the compound.<sup>8</sup> This solution was hydrolysed with 7% sulphuric acid and the hydrolysate thoroughly shaken with ethyl acetate, when some more ellagic acid was obtained.

It is interesting to note that ellagic acid (possibly along with its glycoside) is present in appreciable amounts in these flowers in association with the flavonols as in the flowers of *Eugenia jambolana*<sup>6</sup> and their co-occurrence has some significance in the biogenesis of flavonoids. It may also be mentioned that literature on the isolation of ellagic acid from flowers seems to be scanty.

The stem bark was examined in the same manner. It was found to contain a high proportion of phlobatannins as reported earlier. No ellagic acid could be isolated. The ether and ethyl acetate layers, however, answered characteristic tests for hydroxy anthraquinone derivatives (Börntrager's test—rose; alc. magnesium acetate—pink to orange; aqueous sodium hydroxide—pink; conc. nitric acid—yellow changing to yellowish-green and brown; conc. H<sub>2</sub>SO<sub>4</sub>—yellow changing to pink and reddish-brown) and showed absorption maximum (ethylacetate solution) in the region of 430–440 m $\mu$ . (cf.  $\lambda_{\text{max}}$  for frangula emodin, 440 m $\mu$ ).<sup>9</sup>

Further work on the isolation by mean of adsorption chromatography and characterisation of the anthraquinone compounds has been taken up.

The leaves were also examined for the presence of leucoanthocyanidins according to the method of Bate-Smith<sup>10</sup> and the leuco compound was identified to be leucocyanidin by the formation of cyanidin chloride (acid hydrolysis) which was characterised by its absorption maximum and R<sub>f</sub> values on paper chromatography. Leucodelphinidin was also present in traces.

We thank Prof. T. R. Seshadri for his kind interest and a sample of morin for comparison, and Dr. S. G. Vengsarkar for encouragement,

Medical College, A. G. R. NAIR.  
Pondicherry, S. SANKARA SUBRAMANIAN.  
September 20, 1962. K. SRIDHARAN.

1. Kirtikar, K. R. and Basu, B. D., *Indian Medicinal Plants*, Second Edition. (L. N. Basu, Allahabad), 1935, 1, 664.
2. *The Wealth of India, Raw Materials*, Council of Scientific and Industrial Research, New Delhi, 1962, 6, 27.
3. Block, R. J., Durrum, E. L. and Sweig, G., *A Manual of Paper Chromatography and Paper Electrophoresis*, Academic Press, New York, 1958, p. 330.
4. Pankejamani, K. S. and Seshadri, T. R., *Proc. Ind. Acad. Sci.*, 1952, 36A, 161.
5. Paech, K. and Tracey, M. V., *Modern Methods of Plant Analysis*, Springer Verlag, Berlin, 1955, 3, 526.
6. Nair, A. G. R. and Subramanian, S. S., *J. Sci. and Ind. Res.*, 1962, 21B, 457.
7. Briggs, I. H., Cambie, R. C., Lowry, J. R. and Seelye, K. N., *J. Chem. Soc.*, 1961, 644.
8. Nair, A. G. R. and Subramanian, S. S., *Curr. Sci.*, 1962, 31, 504.
9. Paech, K. and Tracey, M. V., *Modern Methods of Plant Analysis*, Springer Verlag, Berlin, 1955, 3, 559.
10. Bate-Smith, E. C., *Biochem. J.*, 1954, 58, 122.

#### A NOTE ON TICK PARALYSIS IN RABBITS

Tick paralysis in man and animals, caused by the rapidly engorging Ixodid and Argasid ticks, has been reported from many parts of the world. Among the species incriminated for causing tick paralysis so far are: *Ixodes ricinus*, *Ixodes holocyclus*, *Ixodes pilosus*, *Ixodes rubicundus*, *Hæmaphysalis cinnabarina punctata*, *Dermacentor andersoni*, *Dermacentor variabilis*, *Rhipicephalus sanguineus*, *Argas persicus*, and *Ornithodoros lahorensis*. The purpose of this note is to place on record the phenomenon of tick paralysis caused in rabbits by a species of *Hæmaphysalis* in the laboratory in India.

While attempting to colonize *Hæmaphysalis* sp. [soon to be described and named as *H. kutchensis* (H. Trapido, Personal communication)] adult ticks reared from nymphs collected in Kutch were released on a two-month old rabbit. After ten days when all the seven female ticks released on the rabbit were engorging rapidly, the rabbit was found paralysed. The rabbit was unable to stand and all the four limbs were weak and stretched in an extended position. The rabbit was sacrificed and the suspensions of brain, spleen and blood were inoculated into three-day and three-week old Swiss laboratory mice. No infectious agent was isolated.

Later, more ticks were obtained from Kutch and were reared in small batches for two generations on old rabbits (more than one year old) which did not show any paralysis. However, when ten male and ten female ticks reared in the laboratory were released on young rabbits (four to five months old) they developed paralysis, within seven to ten days depending upon the progress of the feeding of the ticks. These observations confirmed the previous experience that rapidly engorging females of *Hæmaphysalis kutchensis* were responsible for paralysis in young rabbits.

At the onset of the disease, which coincided with final stage of engorgement of the female ticks, the rabbits were lethargic and appeared to be generally indisposed, with weakness of all the four limbs. Within two to three days there was a rigid paralysis in extended position of all the four limbs, with occasional irregular involuntary movements.

Soon after the ticks dropped or were removed, the older rabbits recovered quickly and within a day or so they looked normal. However, the paralysis in baby rabbits (one month old) usually proved fatal. These observations on onset of paralysis and recovery from it are similar to those reported from other countries and with other species of ticks.

In the next series of experiments, attempts were made to determine the number of ticks required to produce paralysis in four-five-month old rabbits. Different numbers of ticks, i.e., four, ten and 20 (with equal number of males and females), in groups were released on rabbits, using two rabbits for each group. The rabbits with ten and 20 ticks came down with paralysis, while the rabbits with smaller numbers of ticks remained unaffected. Thus it seems that in order to produce paralysis in young rabbits there have to be an adequate number of ticks all engorging at the same time.

Virus Research Centre, K. R. P. SINGH.\*  
Poona, January 5, 1963.

\* Research Officer, Virus Research Centre, Poona.

#### PRODUCTION OF NEUROLATHYRISM IN CHICKS BY THE INJECTION OF LATHYRUS SATIVUS CONCENTRATES

THE syndrome of "Lathyrism" characterised by spastic paraplegia, in human subjects subsisting on the pulse *Lathyrus sativus*, has been reported by several workers.<sup>1-5</sup> The disease has been known to be endemic in parts of Central India, where *L. sativus* happens to be

staple food among the poor segments of the population. Several attempts to induce neuro-lathyrism in experimental animals have proved unsuccessful. It has been shown that  $\beta$ -amino propionitrile, the toxic factor associated with *L. odoratus*,  $\alpha, \gamma$ -diaminobutyric acid, the factor in *L. latifolius*, and  $\beta$ -cyano-L alanine in *Vicia sativa*, are not concerned in the development of neuro-lathyrism associated with the consumption of *L. sativus*.<sup>1,6,7</sup>

In the present communication, induction of neurological symptoms in chicks injected with *L. sativus* concentrates is being reported.

and minerals. It was known that, on the above diet, the chicks could develop normally.

Intraperitoneal injections of 0.2 to 0.6 ml. of *L. sativus* extract were given from the first day of experimentation. It was observed that in a number of birds receiving such injections, symptoms suggestive of neural involvement were produced. The common abnormality frequently noted was retraction of head and twisting and stiffening of neck (Fig. 1). Paralysis resulting in inability of the bird to stand and move about, was also noted in some instances (Fig. 2). Injections of thiamine as thiamine



FIG. 1



FIG. 2

An alcoholic extract of *L. sativus* powder was prepared as follows: Two thousand grams of powdered *L. sativus* seeds were treated with 6 litres of 30% ethyl alcohol, stirred for 24 hours at 5° C., and allowed to settle for the next 24 hours at the same temperature. The material was then filtered through muslin cloth, and the residue washed twice with 30% ethyl alcohol (4 litres each). A final filtration was undertaken to obtain a clear fluid. The whole bulk was then concentrated under vacuum at 65°–70° C. to a volume of 320 ml. allowed to settle in cold, and filtered. The protein content of this concentrate was about 8.4% (Kjeldahl method).

One-day old white Leghorn chicks (av. wt. 32–40 gm.), obtained from the local hatchery and maintained in electric bulb heated brooders, were used for the experiment. Feeds and water were given *ad libitum* from the first day of experimentation. The basal diet employed contained protein 27.91%, calcium 2.8%, and phosphorus 1.2%, and was composed of the ingredients like ragi, wheat bran, groundnut cake, fish meal, etc., supplemented with vitamins

hydrochloride (1.5 mg./chick) either before or after the administration of the lathyrus extracts, had no beneficial effect. It was noted that when lower levels of dosage were employed, these symptoms were transient and the birds tended to recover therefrom, in about 10–12 hours. However, with injections of successive small doses daily, or injections of higher doses, the symptoms were permanent. In subsequent batches of birds, it was possible to produce similar symptoms using the intramuscular and subcutaneous routes of injection as well.

To rule out the possibility that these symptoms could be anaphylactoid in nature, treatment of the birds with antisthine, adrenaline and predsolan, was attempted. It was found that such pre-treatment had no beneficial effect (Table I). Injections of histamine and acetylcholine, did not bring about such symptoms in the chicks.

Ethyl alcohol extract-concentrate of *Cicer arietinum* (Bengal gram) powder produced in the same manner as the lathyrus extracts with protein content of 8.4% was injected in similar fashion as *L. sativus* extract, in another group

TABLE I

Effects of different drugs with and without  
*Lathyrus sativus* (L.S.) extract

Group No.	No. of chicks	Pre-treatment (1-5 days) and continued during treatment period	No. showing neural symptoms during 1-5 days	Treatment period 6-11 days	No. showing neural symptoms during 6-11 days
1	10	Histamine (1 mg./ml.), 0.1 ml. per chick (I.M.)	nil	No. treatment	nil
2	10	Acetyl choline (20 mg./ml.), 0.1 ml. per chick (S.C.)	nil	No. treatment	nil
3	10	Antistine (1 mg./ml.), 0.2 ml. per chick (S.C.)	nil	L.S. extract 0.3 ml.	7
4	10	Adrenaline (1 ml. of 1:1000 diluted to 25 ml.), 0.2 ml. per chick (S.C.)	nil	L.S. extract 0.3 ml.	8
5	10	Predsolon (5 mg./20 ml.), 0.2 ml. per chick (I.M.)	nil	L.S. extract 0.3 ml.	10
6	10	L.S. extract 0.2 ml. per chick (I.P.)	10	..	..

I.M.: Intramuscular; S.C: Subcutaneous; I.P. Intra-peritoneal. Histamine as histamine acid phosphate; Acetylcholine as acetyl choline chloride; Antistine as antazoline methane sulphonate; Predsolon as Prednisolone hemisuccinate of sodium.

of chicks. No symptoms suggestive of neural involvement could be produced (Table II). The mortality was, however, higher in chicks receiving the Bengal gram extract.

TABLE II

Comparison of neurotoxic effects of Bengal gram (B.G.) and *Lathyrus sativus* (L.S.) extracts with and without antistine

Group No.	No. of chicks	Material injected	No. affected with neural symptoms
1	8	L.S. extract only 0.2 ml. (I.P.)	2
	8	L.S. extract only 0.6 ml. (I.P.)	6
2	8	B.G. extract only 0.2 ml. (I.P.)	Nil
	8	B.G. extract only 0.6 ml. (I.P.)	Nil
3	8	Antistine 0.2 ml.+0.2 ml. of L.S. extract (I.P.)	4
	8	Antistine 0.2 ml.+0.6 ml. of L.S. extract (I.P.)	7
4	8	Antistine 0.2 ml.+0.2 ml. of B.G. extract (I.P.)	Nil
	8	Antistine 0.2 ml.+0.6 ml. of B.G. extract (I.P.)	Nil
5	8	Antistine 0.2 ml. (I.P.)	Nil

I.P.: Intraperitoneal.

Investigations of biochemical, histopathological changes, isolation and characterisation of the active principle(s) involved, are in progress.

Nutrition Research Lab., DWIJENDRA NATH ROY.\*  
Ind. Coun. Med. Res., V. NAGARAJAN.  
Hyderabad, India, C. GOPALAN.  
December 7, 1962.

1. Selye, H., "Lathyrism", *Rev. Canad. Biol.*, 1957, 16 (1), 1.
2. Ganapathy, K. T. and Dwivedi, M. P., Indian Council of Medical Research Publication, 1961.
3. Chopra, R. N., "Lathyrism", *The British Encyclopedia of Medical Practice*, 1935, 631, London, 7.
4. Stockman, R., "Lathyrism," *Edinburgh Med. Jour.*, 1917, 19, 277.
5. —, "Lathyrism in man," *Ibid.*, 1917, 19, 299.
6. Ressler, C., Redstone, P. A., and Erenberg, R. H., *Science*, 1961, 134, 188.
7. —, *Jour. Biol. Chem.*, 1962, 237, 733.

\* CSIR Pool Officer.

### A MODIFIED TECHNIQUE FOR THE SEPARATION OF OVERLAPPING AMINO-ACIDS

ONE drawback of the circular paper chromatography<sup>1,2</sup> is that the same chromatogram cannot be easily used for two-dimensional separation with different solvent mixtures as is possible with a rectangular paper. To separate the amino-acids which overlap even after multiple development with one type of solvent mixture, the mixed band has, therefore, to be re-chromatographed on a separate paper. Different techniques<sup>3,4</sup> have been used for this purpose. In all the techniques the mixed band separates into circles or arcs resulting in longitudinal spreading and considerable weakening of the colour that develops after staining.

For our work, which involved the use of a Photovolt densitometer for quantitative estimation, curved bands longer than one inch and of weaker colours were not suitable. The technique of Giri *et al.*<sup>3</sup> was unsatisfactory for us further because, in addition to the inherent disadvantage mentioned above, time has first to be spent in transferring the mixed band on to another paper and then in running the chromatogram. Further, the worker is constantly engaged during the first operation in order to keep the spot within dimension. These difficulties have been overcome by us using a different technique while retaining the use of both, the apparatus for circular paper chromatography and the method of developing as recommended by these workers.

A steel wire of sufficient tensile strength (dia. 2.05 mm.) was shaped into a frame 'abcdef' (Fig. 1), length 17 cm. × width 4 cm. × height 5 cm. keeping the projection 'ab' equal to about two-tenths of an inch. The frame was coated with wax in order to prevent rusting. Two

springs  $S_1$  and  $S_2$  were shaped out of silver wire (dia. 0.54 mm.) and fastened to the frame as shown. A one-inch wide strip of chromatography paper was hooked on to these springs on one side of the frame and to the projection 'ab' on the other. The mixed band from another sector chromatogram was cut out<sup>3</sup> in the form of a strip ( $Str_1$ ) and stitched at X. Either this ( $Str_1$ )<sup>1</sup> or a separate 0.5 cm. wide strip of filter-paper ( $Str_2$ ) fastened to the first one, served

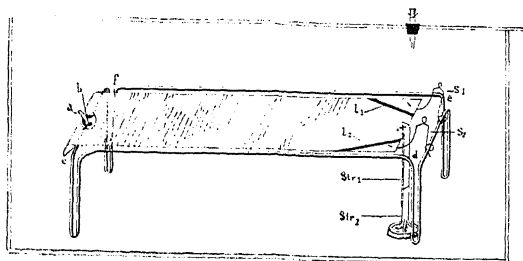


FIG. 1

as the wick. Two thick lines  $l_1$  and  $l_2$  of molten wax, stamped obliquely on the chromatography paper, served to guide the irrigating solvent and prevent sideways spreading of the amino-acids. The entire set-up was placed in the glass trough used for circular chromatography and the chromatogram allowed to run in the usual manner. In this way, the transfer and separation of the mixed amino-acids was carried out simultaneously and did not require any more attention until after the separation. The different mixed bands, e.g., glutamic acid-threonine and aspartic acid-serine-glycine, which required the same type of solvent mixture, could be resolved on separate frames kept alongside in the same trough. Alternatively, the different chromatography strips could be fixed on the same frame after suitably modifying its size and structure. The amino-acids separated in this manner did not spread and the stained bands, which were dense and confined to one-inch width, were quite suitable for reading in the densitometer.

Thus, the technique, in addition to being more suited to our needs, is simpler, quicker and more economical than that of Giri et al. (loc. cit.). The frame and the springs could be shaped in the laboratory within a few minutes and, unlike their apparatus, did not have to be specially constructed by workmen.

Departments of Anatomy and V. A. SHINDE.  
Pharmacology, I. P. AGARWAL.  
G. R. Medical College, S. C. L. VERMA.  
Gwalior, September 21, 1962. R. K. JAIN,

1. Block, R. J., Durrum, E. L. and Zweig, G., *A Manual of Paper Chromatography and Paper Electrophoresis*, Academic Press, New York, 2nd Ed., 1958, 37, 43.
2. Giri, K. V. and Radhakrishnan, A. N., *J. Indian Inst. Sci.*, 1953, 35 (2), 143.
3. — and Rao, N. A. N., *Ibid.*, 1953, 35 (4), 343.
4. Airan, J. W., *Curr. Sci.*, 1953, 22, 51.

## ECONOMIC SIGNIFICANCE OF STUDIES ON SEDIMENTATION IN RAJAHMUNDRY AREA, ANDHRA PRADESH

As part of the investigations, initiated by late Prof. C. Mahadevan, on the nature of sedimentation and environments of deposition during Tertiary along the east coast of Andhra Pradesh, the author mapped about 400 sq. miles of area in the Nellore district<sup>1</sup> and 150 sq. miles near Rajahmundry in the East Godavari district. The areas were geologically mapped on one inch to a mile scale.

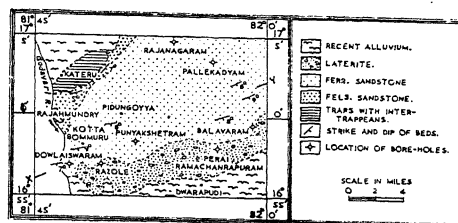


FIG. 1. Geological map of Rajahmundry area.

The formations met with in this area are as follows:

Alluvium	..	Recent
Laterite	.. Reddish brown with cavities, weathering into ochres in places	Pleistocene(?)
Rajahmundry Sandstones	(b) Ferruginous sandstones intercalated with clay iron stones and pink and white clays	Miocene
	(a) Felspathic sandstones with loose conglomerates of 1 to 10 feet thickness at the base	
Traps with intertrappean peans	Three basalt flows separated by two intertrappean beds of marl and lime-stones	Cretaceous-Eocene

Eight boreholes were put by the Exploratory Tubewells Organisation of the Government of India in East Godavari district in the course of their investigation for ground water. The location of seven of these wells are shown in Fig. 1 and the eighth one is at Anuru ( $17^{\circ} 3' : 82^{\circ} 2' 30''$ ), which is 7 miles due east of Palleka-

diam, in the area adjoining the present one. The log from these eight boreholes supplemented by the data collected during field-work were all utilised in drawing a panel diagram to delineate changes in facies in three dimensions. Figure 2 is a simplified section showing the changes in the sediments with depth.

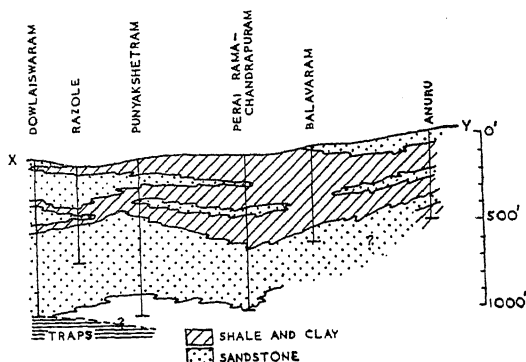


FIG. 2 Diagrammatic section along XY in Fig. 1.

From the panel diagram the following conclusions are arrived at:

(i) Lithologically the Rajahmundry formation is made up of conglomerates, sandstones, shales and clays. These are mutually intercalated with each other, but yet show predominance of one over the other in certain regions.

(ii) The thickness of the Rajahmundry formation is not less than 900 feet as the top of the traps is met with at the borehole in Dowlaiswaram at a depth of about 900 feet from the ground level (86 feet).

(iii) The formation thickens due south-east as can be inferred from the fact that the trap is not met even at a depth of 1,000 feet from ground level (95 feet) at Punyakshetram.

(iv) Though the thickening of the formation is generally due south-east, yet it is found that the gravels seem to give place to sandstones and they in turn to shales and clays as one observes the sections of the panel diagram from Dowlaiswaram in the south-west towards Anuru in the north-east. This may be evident from the diagrammatic section in Fig. 2 as well.

During the course of geological mapping white and pink clays were observed at Kotta Bommuru and Punyakshetram, in a quarry in the former and below ground level in the latter and both are being exploited intermittently. Besides these, a clay horizon was seen in a well 3/4 mile S.S.E. of Balavaram. It may also be mentioned that the occurrence of clay has been reported<sup>2</sup> from Peddapuram (17° 5' : 82° 8' 30") which is in the area east of the one under in-

vestigation. On the basis of field observations as well as borehole data it is inferred that the shale and clay horizons are likely to thicken and predominate in a direction due east of Rajahmundry and it is further suggested that the area enclosed by the villages of Punyakshetram, Pallekadyam and Balavaram is worth prospecting for clay deposits.

The author is grateful to the Exploratory Tubewells Organisation of the Government of India for kindly permitting him to use the borehole data for purposes of this study. The financial assistance of the C.S.I.R., is thankfully acknowledged.

Geology Department, R. VAIDYANADHAN.  
Andhra University,  
Waltair, September 20, 1962.

1. Vaidyanadhan, R., *Curr. Sci.*, 1962, **31** (6), 231.
2. Krishnan, M. S., *Mem. G.S.I.*, 1951, **80**, 53.

#### A PRELIMINARY NOTE ON THE OCCURRENCE OF A RADIOACTIVE UPPER VINDHYAN PELITIC SANDSTONE

THE aim of the present note is to draw attention to the occurrence of a radioactive facies within the Upper Vindhyan. The rock is a grey pelitic variation of the Rewa Sandstone, and was noticed by the author around the village of Satanwara (25° 32' 24" : 77° 44' 23") in the course of a reconnaissance radiometric survey of parts of Shivpuri District, Madhya Pradesh, included in the Survey of India topo-sheet No. 54 G/NE. The importance of this find lies in the fact that it is the first record of a radioactive rock of this type in the Vindhyan formations of India.

**Geological Setting and Mode of Occurrence.**—The radioactive horizon occurs within the Lower Rewa Sandstone. A study of vertical sections in quarries has revealed that the radioactive sandstone forms thin layers, beds and lenses upto 1 foot in thickness within purple and white sandstones which are either gently dipping or horizontal. Strong current bedding is noticed in the sandstones wherever they are associated with the grey radioactive facies.

**Radioactivity and Uranium Content of the Rock.**—The rock shows a radioactivity upto 12 times the background radiation and has assayed upto 0.160% equivalent  $U_3O_8$  radiometrically, and 0.03%  $U_3O_8$  chemically.

**Characters of the Rock.**—The rock is a fine-grained banded sandstone of subordinate pelitic composition. It is fissile and easily parts in



thin layers, each successive lamina showing a grey crust. Thin section studies have shown the texture of the rock to be very fine-grained. Banding is conspicuous and is a result of alternating seams of colourless and black materials, the former being of a quartzo-felspathic composition with mica, and the latter showing a concentration of heavy minerals, prominent amongst them being zircon, tourmaline and rutile (Fig. 1).

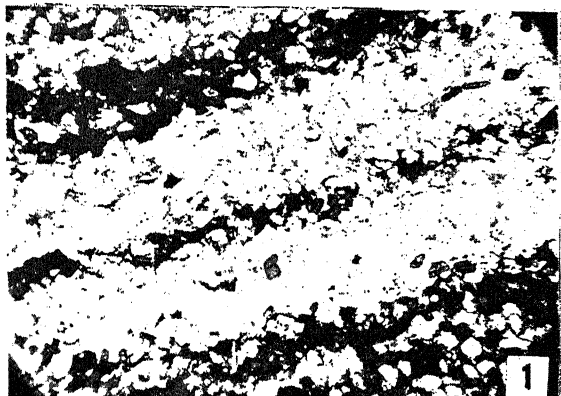


FIG. 1

to Mr. K. K. Dar and Mr. A. V. Phadke for their guidance and helpful suggestions.

Atomic Minerals Division. S. VISWANATHAN.  
Dept. of Atomic Energy,  
Government of India,  
New Delhi-5,  
December 24, 1962.

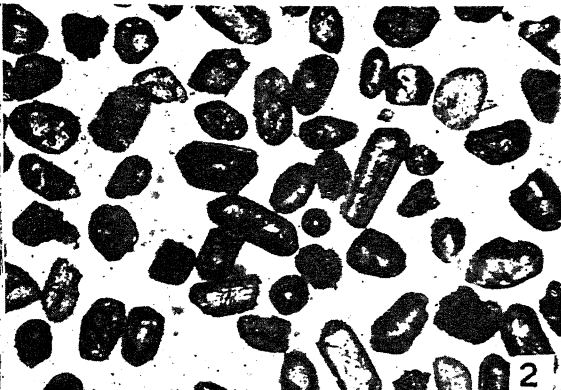


FIG. 2

*The Radioactive Constituents of the Rock.*—Preliminary studies have indicated that most of the radioactivity of the rock springs from its pelitic cementing matrix. A part of it is also contributed by the zircons, a remarkable concentration of which is noticed in the rock. Some of the zircon grains are metamict, while others possess weakened birefringence due to radioactive damage (Fig. 2).

A preliminary comparison of the heavy mineral assemblages in this sandstone and in the Bundelkhand Granites occurring to the east of the area has shown a correspondence between the two, thereby suggesting that the source material for the sediments may have been derived from the latter. It also seems possible that some of the uranium released from uraniferous chlorites which have been observed in some parts of the neighbouring Bundelkhand Granite outcrops by the author may have found its way in small quantities into the sandstone.

The radioactive sandstone is under investigation and further work may yield data which may lead to a more conclusive inference regarding its provenance and uranium content.

I am very grateful to Dr. D. N. Wadia for kindly permitting publication of this paper and

#### STRATIGRAPHIC POSITION OF THE SEDIMENTARY ROCKS NEAR NURDA AND HATGAMARIA, SINGHBHUM, BIHAR

In the course of geological mapping of the area around Hatgamaria ( $85^{\circ} 44' : 22^{\circ} 16'$ ) in Singbhum District, Bihar, three detached outcrops of quartzitic sandstones were met with : one in the neighbourhood of village Mirgilindi ( $85^{\circ} 42' : 22^{\circ} 17'$ ) in the west, the other to the east of Hangraburu near Hatgamaria and the third near village Baljori ( $85^{\circ} 43' : 22^{\circ} 17'$ ), east of Nurda P.F. in the north (Fig. 1). The outcrop near Baljori shows associated pink shale which is absent from the other two regions. The outcrop of sandstone, north of Hatgamaria, is not shown in the earlier map by Jones.<sup>1</sup>

About the Nurda group of rocks Dunn<sup>2</sup> was doubtful as to whether these shales and sandstones should be grouped as Kolhans or Iron Ore Series rocks. The writer has attempted to establish the stratigraphic position of the Nurda and Hatgamaria sediments, with the help of petrographic studies and heavy mineral analysis.

*Kolhan Sandstone.*—The Kolhan sandstone near Mirgilindi is a fine-bedded, well-jointed flaggy sandstone of poor sorting and purplish

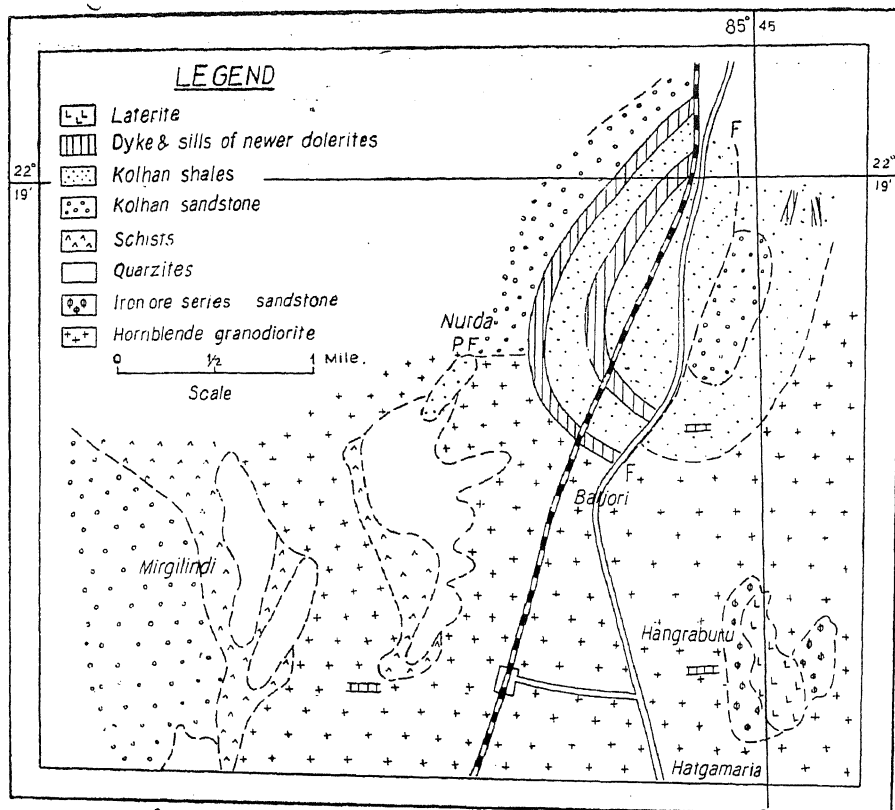


FIG. 1. Geological map of the area around Hatgamaria, Dist. Singhbhum, Bihar

colour, often conglomeratic at the bottom, and dipping gently westward. The rock consists of subrounded grains of dominant quartz, frequent fragments of shale and a few fragments of chert. The matrix is either secondary silica, or argillaceous material, and ferruginous at places.

**Nurda Occurrence.**—The quartzitic sandstones and phyllitic shales around Nurda P.F. have been folded into an open northerly plunging syncline and have been intruded by two parallel sills of dolerites (Fig. 1). Truncating the eastern limb of the fold runs a fault.<sup>3</sup>

The shale is typically soft, pink in colour, very fine-bedded; and the sandstone is either white or brown in colour, coarse-grained, and locally conglomeratic with obscure bedding. The rock consists of very coarse-grained, poorly sorted, inequant, subangular grains of quartz and occasional quartzite and shale fragments.

**Quartzitic Sandstone North of Hatgamaria.**—This sandstone outcrop, covering an area of nearly 3/4 by 1/4 of a mile, is traversed by a north-south trending band of lateritic Mn-Fe-Ore of 300 yds. in thickness. The rock is white

coloured, with fairly well preserved bedding and consists of quartz; subhedral to euhedral potash-feldspar, subhedral plagioclase, quartzite and shale and ferruginous chert fragments. The sericite flakes lie along cracks. The grains are mostly interlocked with secondary overgrowth.

Table I shows the heavy mineral content of the three sandstone occurrences.

TABLE I

Heavy Mineral Frequency in per cent.

	Mirgilindi		Nurda		Hatgamaria	
	H 12	H 13	H 21	H 22	H 32	H 33
Tourmaline ..	23.2	15.5	12.2	9.1	15.4	12.2
Zircon ..	14.6	11.1	23.1	14.5	21.4	26.9
Garnet ..	..	..	1.5	2.1	3.5	4.1
Rutile ..	..	..	..	..	14.2	15.1
Amphibole ..	..	..	..	..	3.2	..
Chloite ..	not counted		..	..	..	..
Hematite and Limonite	61.2	73.4	63.2	74.3	..	..
Magnetite and Ilmenite	..	..	..	..	42.3	41.7

TABLE II

	Rao (*)	Saha <sup>5</sup>	Mehera <sup>6</sup>	Present worker
Kolhan series	1. Rutile absent ..	1. Zircon scarce (Mauve absent)	1. Mauve Zircon absent	1. Green Tourmaline abundant
	2. Tourmaline abundant ..	2. Actinolite absent	2. Actinolite absent	2. Brown Zircon frequent
	3. Zircon less common and brownish, clouded and zoned	3. Tourmaline common	3. Tourmaline abundant	
	4. Magnetite absent ..	4. Garnet and Epidote absent	4. Epidote rare	
	5. Hematite common ..			
	6. Amphibole rare ..			
Iron ore series	1. Rutile dominant ..	1. Zircon dominant. (Colourless and mauve)		1. Brown Tourmaline frequent
	2. Tourmaline absent ..	2. Actinolite common		2. Pink Zircon abundant
	3. Zircon common and mostly pinkish	3. Tourmaline absent		3. Rutile abundant
	4. Magnetite common ..	4. Garnet and Epidote occasionally present		4. Garnet few
	5. Hematite absent ..			5. Amphibole (Tremolite) few
	6. Amphibole common ..			

(\*) *Vide* Sarkar and Saha, 1962.<sup>4</sup>

These heavy mineral data have been compared with those obtained by previous workers in Table II.

Taking into consideration the petrographic characters, the Hatgamaria quartzitic sandstones, being arkosic, might be correlated, after Saha,<sup>5</sup> with Iron Ore Series. Over and above, the Hatgamaria occurrence has, among its heavy mineral assemblage, Rutile, pink Zircon and Amphibole, which are also suggestive of Iron Ore Series age for this sandstone. The occurrence of brown Tourmaline in this association was not, however, recorded by previous workers.

On the other hand, Nurda and Mirgilindi occurrences are marked by absence of Rutile and Amphibole, lesser frequency of pink Zircon; relative abundance of brownish Zircon and green Tourmaline. Therefore Nurda sediments are closely comparable with the Mirgilindi sandstones which form a part of the Kolhan basin from Chaibasa to Noamundi. Disregarding the disparity that may arise from the occurrence of Garnet, all other evidences suggest Kolhan age for this sandstone.

I am indebted to Dr. A. K. Saha for his guidance in this work.

ANJAN KUMAR CHATTERJEE.

Geological Laboratory,  
Presidency College,  
Calcutta-12, September 4, 1962.

1. Jones, H. C., *Memoir Geol. Surv. Ind.* 1934  
63 (2).

2. Dunn, J. A., *Ibid.*, 1940, 63 (3).

3. Raha, P., *Bhu-Vidya*, 1959-60, 23, 31.

4. Sarkar, S. N. and Saha, A. K., *Q.J.G.M.M.S.I.*, 1962, 34, 97.

5. Saha, A. K., *Sci. and Cult.*, 1948, 14, 77.

6. Mehera, S. L., *M.Sc. Thesis*, Calcutta University, 1956 (unpublished).

### SCUTELLAR BRISTLES IN *CULICOIDES* (DIPTERA: CERATOPOGONIDAE)

THE present communication deals with the scutellar bristles of 31 species of *Culicoides* prevailing in countries from Africa through India to Ceylon, Borneo, Philippine Island and Taiwan.

Scutellum, a narrowly transverse chitinous strip on the dorsal aspect of thorax; is rounded at middle of its posterior margin with somewhat concave sides and flat anterior border in the *Culicoides*. Excepting colour pattern of the area, nothing else from it is noted by the taxonomists in describing their species. But Carter *et al.*<sup>1</sup> drew attention to the bristles present as hairy processes on the scutellum and furnished some information on the Gold Coast (Africa) *Culicoides*. And although their work showed remarkable constancy of these structures at intraspecific level as well as striking variation in number and distribution at interspecific level within the genus, nothing significant has been done since then in this respect. As a result, we have no knowledge of this infallible feature in most of the *Culicoides* of the world known today.

In the present study, *C. schultzei* (End.) was selected for detailed investigation. Scutellum

TABLE I

Species	No., sex and locality of materials (F—female: M—male)	No. of bristles	Figure reference
<i>S.g. Trithecoides</i> W. & H.			
Anophelis group			
1. <i>anophelis</i> Edw.	.. 11 F., 4 M.; India, Ceylon, Malaya & Thailand	3	I
Flavescens group			
2. <i>flavescens</i> Macf.	.. 1 F.; Malaya	3	II
3. <i>subflavescens</i> W. & H.	.. 1 F.; North Borneo	3	III
4. <i>paraflavescens</i> W. & H.	.. 1 F.; Ceylon	3	IV
Macfiei group			
5. <i>humeralis</i> Okada	.. 2 F.; Thailand	3	V
6. <i>palpifer</i> Das Gupta & Ghosh	.. 12 F., 8 M.; India, Malaya, Thailand & Philippine Islands	3	VI
Raripalpis group			
7. <i>elbeli</i> W. & H.	.. 2 F., Thailand	3	VII
8. <i>raripalpis</i> Smith	.. 3 F., 2 M.; India, Sikkim & Malaya	3	VIII
9. <i>gewertzi</i> Causey	.. 3 F., 2 M.; Malaya & North Borneo	3	IX
10. <i>albibasis</i> W. & H.	.. 2 F., 1 M.; Malaya	3	X
11. <i>barnetti</i> W. & H.	.. 2 F., Malaya	3	XI
12. <i>flaviscutatus</i> W. & H.	.. 3 F., 1 M.; Malaya, Thailand & North Borneo	3	XII
<i>S.g. Culicoides</i> , s. str., (?) group			
13. <i>geminus</i> Macf.	.. 3 F., 1 M.; Malaya	21	XIII
14. <i>autumnalis</i> Sen & Das Gupta	.. 3 M.; India	4	XIV
Peregrinus group			
15. <i>peregrinus</i> Kieff.	.. 10 F., 9 M.; India	4	XV
Chiopterus group			
16. <i>orientalis</i> Macf.	.. 3 F., 2 M.; India	3	XVI
17. <i>innoxius</i> Sen & Das Gupta	.. 12 F., 7 M.; India	6	XVII
18. <i>fulvus</i> Do.	.. 4 F., 3 M.; India	3	XVIII
19. <i>turgidus</i> Do.	.. 6 F., 6 M.; India	4	XIX
<i>S.g. Oecacta</i> Poey, (?) group			
20. <i>minutus</i> Sen & Das Gupta	.. 8 F.; India	3	XX
Clavipalpis group			
21. <i>candidus</i> Sen & Das Gupta	.. 2 F., 1 M.; India	10	XXI
22. <i>distinctus</i> Do.	.. 1 F., 2 M.; India	4	XXII
Furens group			
23. <i>huffi</i> Causey	.. 3 F., 1 M.; Malaya & North Borneo	9	XXIII
24. <i>similis</i> C. I. & M.	.. 5 F., 3 M.; India & Thailand	10	XXIV
25. <i>shortti</i> Smith & Swaminath	.. 2 F., 2 M.; Malaya & Thailand	8	XXV
26. <i>fortis</i> Sen & Das Gupta	.. 2 F.; India	8	XXVI
Schultzei group			
27. <i>schultzei</i> (End.)	.. 35 F., 28 M.; India, Ceylon, Malaya & Thailand	4	XXVII
<i>S.g. Meijerhelea</i> W. & H.			
28. <i>guttifer</i> (Meij.)	.. 2 F., Malaya & Thailand	9	XXVIII
29. <i>mackayensis</i> Lee & Reye	.. 2 F.; Thailand & North Borneo	10	XXIX
30. <i>hegueri</i> Causey	.. 1 F.; Thailand	8	XXX
31. <i>arakawai</i> (Arakawa)	.. 2 F., 1 M.; Thailand & North Borneo	5	XXXI

from both females and males of the species treated previously with weak solution of caustic potash were dissected out and mounted suitably. Whole-mounts of the specimens in phenol-balsam mixture were also considered. In case of other species, only such whole-mount preparations could be considered.

The hairy processes on the scutellum are seen to arise from respective alveolus. All these processes are referred here as bristles and, depending on size, two types in them are noted—larger type with alveolar diameter between 0.012 mm.

and 0.008 mm. (bristles of Carter *et al.*<sup>1</sup>), and smaller type with alveolar diameter between 0.004 mm. and 0.003 mm. (hairs of Carter *et al.*<sup>1</sup>). Observations made now are given in the following tabular form with a reference to the illustrations (Fig. 1: I-XXXI). The illustrations are diagrammatic, a rectangular block representing a scutellar surface and the hollow circles and the dots representing the alveoli of the larger and the smaller types of bristles respectively. The number, relative size and spacing of the bristles as could be seen in the

slide preparations were maintained in the illustrations by plotting the circles and the dots as representative of the alveoli of bristles on graph sheet and having reference to adequate *Camera lucida* projections of the scutellar surfaces. The species are enlisted under subgenera and groups of the genus *Culicoides* following the conception of Khalaf<sup>2</sup> and of Wirth and Hubert<sup>3,4</sup> in this respect.

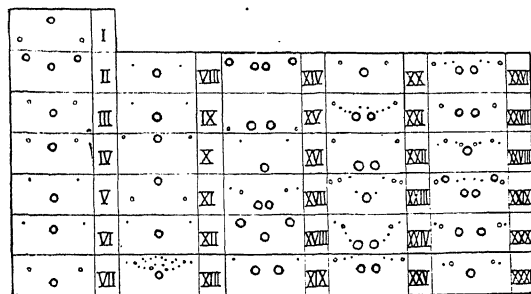


FIG. 1. Diagrams showing distribution of alveoli of bristles on scutellar surface in *Culicoides* spp.

**Comments.**—In 31 species studied now, bristles per scutellum varies between 3 and 21, the lowest number being shared by 15 species and the highest only by *C. geminus*. The intermediary numbers of bristles encountered are 4, 5, 6, 8, 9 and 10, and these occur in 5, 1, 1, 3, 2 and 3 other species respectively. Some kind of larger type of bristles (with alveolar diameter between 0.012 mm. and 0.008 mm.) occur in all but the smaller type (with alveolar diameter between 0.004 mm. and 0.003 mm.) are missing in 11 species. This is also the experience of Carter *et al.*<sup>1</sup> and their data on the scutellar bristles of *C. schultzei* and *C. similis* are confirmed in the present investigation.

The two sexes of a species do not differ in their scutellar bristles. None of the 19 species studied in both the sexes showed any variation. Similarly, no other intra-specific difference of these structures could be found in *C. schultzei* which is regarded as an extremely variable species,<sup>1</sup> and which has been examined now in sufficiently large numbers collected from different localities of its distributional range.

In the primitive *Culicoides*, represented by the subgenus *Trithecoides*, 3 scutellar bristles occur in all the species now studied. The same number of bristles is found only in a few species of the more advanced subgenera like *Culicoides* and *Oecacta*. The primitive subgenus thus appears conservative in this respect

and the specific distinction lies in the differential arrangement of the bristles on the scutellar surface. This reflects a different affinity and brings the species of different groups within the subgenus together. Thus *C. anophelis* and *C. barnetti* appear same, *C. subflavescens* differs from them and resembles *C. paraflavescens* and *C. elbeli* while *C. flavescens* having all three bristles equally stout stands apart. The remaining species, except *C. albibasis*, showing an independent pattern, form yet another category.

I am grateful to Dr. S. Mookerjee, Head of the Department of Zoology, Presidency College, Calcutta, for laboratory facilities, to Dr. W. W. Wirth, of U.S. National Museum, for his donation of a good number of *Culicoides*, and to Dr. P. Sen, of W.H.O., through whose good office the donation was made available.

Zoology Department,

S. K. DAS GUPTA.

Presidency College,

Calcutta, July 31, 1962.

1. Carter, H. F., Ingram, A. and Macfie, J. W. S., *Ann. Trop. Med. and Parasitol.*, 1920, **14**, 187.
2. Khalaf, K., *Ann. Ent. Soc. America*, 1954, **47**, 34.
3. Wirth, W. W. and Hubert, A. A., *Pacific Insects*, 1959, **1**, 1.
4. — and —, *Ibid.*, 1961, **3**, 11.

#### FREE AMINO-ACID CONTENT IN THE CENTRAL NERVOUS SYSTEM OF FRESHWATER CRAB, *PARATELPHUSA JACQUEMONTII* (RATHBUN)

LITTLE is known about the free amino-acid composition of the central nervous system of crustaceans. It was thought, therefore, that the identification of free amino-acids in the brain and thoracic ganglion of *P. jacquemontii* may add to the present knowledge on the free amino-acid make-up of crustacean central nervous system.

About 35 animals were carefully dissected and the pooled brains and thoracic ganglia were ground in a mortar separately in a few ml. of 80% alcohol. Extracts were prepared by the usual method. Separation of amino-acids was done by Rutter's<sup>1</sup> technique as modified by Giri and Rao.<sup>2</sup> The amino-acids were identified with the aid of two dimensional paper chromatograms and some of them were quantitatively estimated with the help of Beckman's spectrophotometer.

The qualitative analysis of the brain and thoracic ganglion showed the presence of cystine, aspartic acid, asparagine, arginine, alanine, tryptophane, serine, lysine, glutamic

acid, glutamine, valine, threonine, tyrosine, glycine, leucine, phenylalanine, proline and  $\alpha$ -aminobutyric acid. Concentration of some of the amino-acids are given in Table I.

TABLE I  
Amino-acid content in  $\mu\text{g./100 } \mu\text{g.}$

Amino Acids	Brain	Thoracic ganglion
Cystine	0.09	0.15
Asparagine	1.05	0.53
Alanine	0.27	0.25
Lysine	0.72	0.4
Glutamic acid	0.42	0.55
Tyrosine	0.22	0.17
Glycine	0.11	0.14
Phenylalanine	0.55	0.02
Valine	0.27	0.07

The values indicate that asparagine has the highest concentration in brain, and glutamic acid and asparagine in thoracic ganglion.

My grateful thanks are due to Dr. P. V. Rangnekar for his guidance and to the Ministry of Scientific Research and Cultural Affairs for a Research Training Scholarship.

Department of Zoology,  
Vidarbha Mahavidyalaya,  
Amravati, Maharashtra,  
September 24, 1962.

H. B. NIRMAL.

1. Rutter, L., *Analyst*, 1950, **75**, 37.
2. Giri, K. V. and Rao, N. A. N., *J. Ind. Inst. Sci.*, 1952, **34** (2), 95.

### SENSORY CANALS OF THE HEAD OF FEW CYPRINIDS

The sensory canals of the head in *Cirrhina mrigala*, *Catla catla*, and *Labeo gonius* have been investigated and have found to be very similar. The course of the canals (Fig. 1) in these fishes was studied in dry skulls either by inserting a hair through these canals or by injections of Indian ink.

The supraorbital canal (sc) extends from nasal to the middle of the parietal. A small continuation of the supraorbital canal runs outwardly to open into a pore at the junction of the frontal, pterotic and the fourth suborbital bones. Here the supraorbital canal joins the infraorbital and temporal canals. There are a number of small branches running laterally from the supraorbital canal; each of these branches opens to the exterior through a pore.

The infraorbital canal (ic) is enclosed by the lachrymal and by all the four suborbitals. At the junction of the fourth suborbital, frontal and pterotic, it opens through a pore to join the supraorbital and temporal canals.

The mandibular canal (mc) is continuous with the preopercular canal (pc), and the latter after passing through the opercular bone joins the temporal canal in the middle of the pterotic bone. Here the view of Lekander<sup>1</sup> is confirmed: "as a rule, the preopercular canal opens in the temporal canal". The temporal canal (tc) is enclosed by the pterotic and supratemporal bones. It joins the supraorbital and infraorbital canals anteriorly and preopercular canal in the middle. A supra-cross-commissural canal (scc) is present in all the three fishes and is enclosed by the posterior margins of the two parietals. A similar canal has been recorded in *Amiurus catus* by Wright<sup>2</sup> and Collinge.<sup>3</sup> Herrick<sup>4</sup> and Kapoor<sup>5</sup> deny its presence in a number of siluroids.

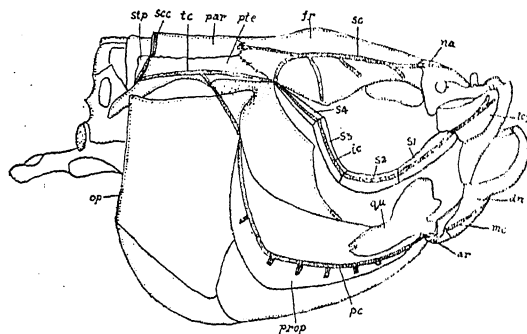


FIG. 1. Skull of *Cirrhina mrigala* showing sensory canals, lateral view;  $\times 2$  ar, articular; dn, dentary; ic, infraorbital canal; fr, frontal; ley, lachrymal; mc, mandibular canal; na, nasal; op, opercular; par, parietal; pc, preopercular canal; pr, preopercular; pte, pterotic; qu, quadrate; s1-4, suborbitals; sc, supraorbital canal; scc, supra cross-commissural canal; stp, supratemporal; tc, temporal canal.

While summing up the characters of the latero-sensory canal system, the following points are noteworthy. The course of the sensory canals in syprinids shows much similarity with a number of siluroids except for an addition of supra-cross-commissural canal and certain other differences in the details. The preopercular canal joins the temporal canal in the region of the pterotic; the supraorbital canal reaches up to the infraorbital canal; and mandibular canal is present which is continuous with the preopercular canal. These observations support the earlier findings by Tretiakov,<sup>5</sup> although they are at variance with the reports of Kapoor.<sup>6</sup>

My sincere thanks are due to Dr. H. S. Chaudhary, University of Gorakhpur, for his valuable guidance.

Department of Zoology, O. P. KHANDELWAL.  
D. A. V. College, Muzaffarnagar,  
September 3, 1962.

1. Lekander, B., *Acta Zoologica* Haft., 1949, **30**, 1.
2. Wright, R. R., *Proc. Canad. Inst. Toronto*, 1884, **2**, 251.
3. Collinge, W. E., *Proc. Zool. Soc., Lond.*, 1895, **2**, 274.
4. Herrick, C. J., *Jour. Comp. Neurol.*, 1901, **11**, 177.
5. Tretiakov, D. K., *Bull. Acad. Sci.*, 1945, **1**, 49.
6. Kapoor, A. S., *Trans. Amer. Micros. Soc.*, 1961, **80**, 329.

### NEUROSECRETORY RELEASE IN THE COCKROACH REVEALED BY VITAL STAINING

CONSIDERABLE information is available to show that the neurosecretory matter from the cells of the insectan brain travel along the axons and reach the corpora cardiaca from where it gets released into the blood-stream.<sup>1</sup> These conclusions were drawn from observations all based on sectioned and stained material at various arbitrary times in experiments; some observations have been presented about the transport of the secretory products along living nerve tracts of *Calliphora* also.<sup>2</sup> In studies on the mapping of embryos of animals, embryologists have developed the technique of tracing cells by selectively applying vital stains like neutral red and Nile blue.<sup>3</sup> A modification of this commonly accepted embryological technique was employed to study the neurosecretory pathways in the cockroach *Periplaneta americana*; a brief report on that is given below.

Neutral red was found to be unsuitable as a stain because it showed a tendency to colour all tissues in a very short time. Methylene blue gave satisfactory results. 1.5% agar strips were soaked overnight in 1% methylene blue and were dried. This strength of the stain was found to be most satisfactory; lesser strength lost colour in pressing while higher strength stained uniformly all tissues. Adult female and male cockroaches were employed in the study. After the removal of the dorsum of the cranium in an anaesthetised insect, the perineurium was carefully opened and the prepared strip of agar was placed and pressed against the pars intercerebralis. The perineurium was replaced and the cranium was closed. The animal recovers from the operation within a few minutes, and after several hours (6 to 84 hours) the animal was dissected, the strip was removed, the endocrine system was dissected out and fixed in concentrated ammonium molybdate for 5 to 10 hours, dehydrated and paraffin sections were cut. The sections were mounted unstained in balsam for study. Many cells of the brain showed a faint bluish tint; the neurosecretory cells, the axonic pathways and the colloids in the corpora cardiaca together with the neural pathways within the latter, were all coloured prominently blue.

It was found that generally in young adult males the neurosecretory picture was comparatively poorly defined and the colouration of the colloids was hazy. In females, the cells and axonic pathways (Fig. 1) were better defined. Thus it will be seen that this method

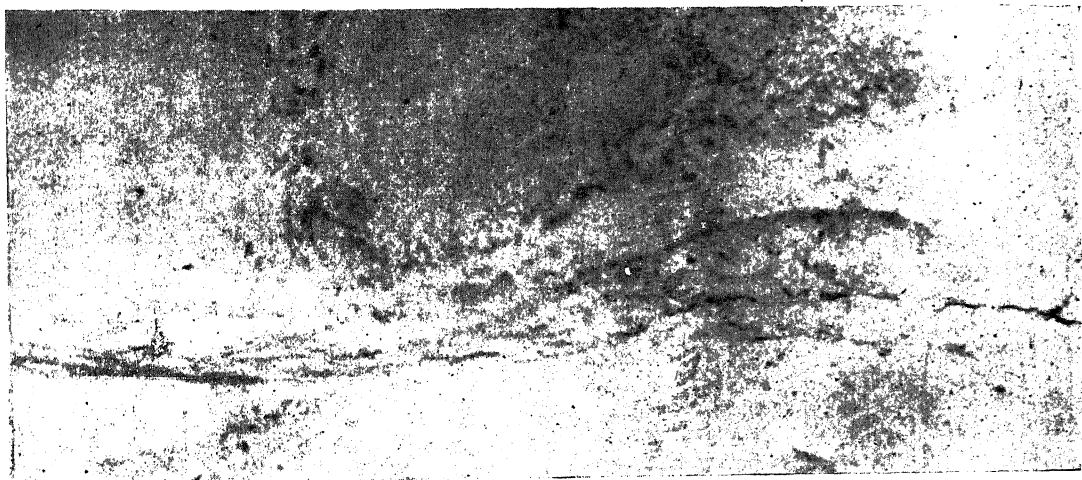


FIG. 1. Photomicrograph showing the neurosecretory tract within the brain of *Periplaneta americana* vitally stained with methylene blue. The streaks represent axonic bundles from the neurosecretory cells of the pars intercerebralis. About  $\times 800$ .

is suitable to follow up the neurosecretory pathways easily in experimental investigations. It was also seen that the removal of the oothecum from a female, carrying one, will produce a prominently stained tract in the preparations; this tract becoming well defined within a short time, about eight hours after the application of the strip the neurosecretory colloids were discernible at the level of the corpora cardiaca. In young females and young males the colouration gets developed in the neurosecretory tract only in the course of several days (3 days and more). The intensity of colouration and the rapidity with which it gets developed at the level of the corpora cardiaca are suggestive of a rapid discharge of the neurosecretory matter from the cells of the brain, when the oothecum gets removed from the insect. This also indicates that the neurosecretory release is somewhat kept in check when the oothecum is within the uterus of the cockroach.

The author is indebted to Professor K. K. Nayar for guidance and to the University of Kerala for the award of a Government of India research scholarship.

Department of Zoology, K. K. THOMAS.  
University College,  
Trivandrum, September 19, 1962.

1. Van der Kloot, W. G., *Ann. Rev. Ent.*, 1960, **5**, 35.
2. Thomsen, E., *J. Exp. Biol.*, 1954, **31**, 322.
3. Rugh, R., *Experimental Embryology*, Minneapolis, 1952.

### A NEW LODGING INDEX FOR THE USE OF MAIZE BREEDERS

FOUR new Indian maize hybrids, suited to different regions of India, have been released. Maize hybrids respond well to heavy fertilization which causes lodging. Resistance to lodging is thus an important characteristic desired in maize hybrids. Since environmental conditions responsible for lodging such as heavy rains, strong winds, and irrigation, do not remain constant, variable degree of lodging is observed under natural conditions and it is, therefore, necessary to find out some index of lodging which can be used for evaluating material for lodging resistance.

Wilson,<sup>1</sup> Hall,<sup>2</sup> Koehler *et al.*,<sup>3</sup> Huber<sup>4</sup> and Shank<sup>5</sup> have suggested different indices for lodging resistance in maize. However, these indices do not take into consideration all the factors affecting lodging and some are very inconvenient to work with. Therefore, the present study was undertaken to find out a suitable and

convenient index for lodging resistance in maize giving due consideration to all the causing and counteracting factors.

During the *kharif*, 1961 year at Delhi, heavy and incessant rains were favourable to lodging. Therefore, detailed observations on plant height and weight, root weight, root number per plant, shoot/root ratio and plant weight  $\times$  height/root weight ratio were taken on 60 lodged and erect plants in top cross yield trials at dry silk stage. These are presented in Table I.

TABLE I

Character	Erect	Lodged	Difference
1 Average angle from vertical	0.0°	44.3°	
2 Plant height	236.5 cm.	239.2 cm.	Not significant
3 Root number	50.5	43.5	do.
4 Root weight	65.8 gm.	24.2 gm.	Significant
5 Plant weight	682.0 gm.	556.0 gm.	Not significant
6 Shoot/root ratio (fresh weight basis)	11.2	25.1	Significant
7 Plant weight (gm.) $\times$ height (cm.)	2695 : 1	6082 : 1	Significant
Root weight (gm.)			

There were striking differences as regards root weight, shoot/root ratio and plant weight  $\times$  height/root weight ratio. It was seen, however, that in some cases the root weight in lodged plants was as high as 39.5 and 60.0 gm. Therefore, root weight alone could not provide a good index of lodging as it did not take into consideration the causal force. The shoot/root ratio and plant weight  $\times$  height/root weight ratio appeared to be good indices of lodging. However, it should be remembered here that the plants with thicker stems and dwarf habit will show high shoot/root ratio but may not be susceptible to lodging. Therefore, plant weight  $\times$  height/root weight ratio appeared to be a better index of lodging since it takes into consideration all the causing factors and gives a clear indication of lodged and erect plants. Further when this ratio was studied as to its magnitude in relation to degree of lodging in lodged plants, it was seen that the lodging angle increased in direct proportion to the increase in this ratio (correlation coefficient of this ratio with lodging angle = +.460 significant at 1% level).

The determination of lodging indices suggested by earlier workers requires the uprooting of the plant before maturity and hence could not be utilized in screening the progeny in segregating generations. With this in view and also to further test this new index, observations were taken in the next season (1962 *kharif*)



at a time just before harvest on the inbred lines whose resistance or susceptibility to lodging could be predetermined as lodging occurred due to favourable environmental conditions. The data are presented in Table II.

TABLE II

Resistant		Index
Inbred		
P5PB5-A3-f	..	2980 : 1
(Ven1 x Ven 400-#)-13-1-f	..	2714 : 1
Peru 330-A4-#-#-1-#-#-#	..	2569 : 1
Ven1-42-f-f-#	..	2670 : 1
Susceptible		Index
Inbred		
A, Theo-21 (B)-f-#-3-f-#-#-#	..	8863 : 1
K1 48	..	5412 : 1
Cau 303-1-f-f	..	6677 : 1
Cos 302-A2-1-#-2-#-#	..	9702 : 1

It will thus be seen that an index of below 3000 with weights in gm. and height in cm. will indicate resistance to lodging. This index can be very conveniently used to screen the inbred lines as well as hybrids for their lodging resistance. As this index can be determined just prior to harvest, it can be used to screen plants in segregating generations also. Indications are there<sup>5</sup> that by backcrossing, it may be possible to transfer the lodging resistance to susceptible types. With the use of this new and convenient index, maize breeders can now go ahead with their programme of breeding for lodging resistance.

This work was carried out under the Co-ordinated Maize Breeding Scheme and the authors gratefully acknowledge the financial help given by the Indian Council of Agricultural Research.

Division of Botany;  
Indian Agricultural

S. M. VAIDYA.  
R. L. PALIWAL.  
BHAG SINGH.

Research Institute,  
New Delhi, November 28, 1962.

1. Wilson, H. K., *J. Am. Soc. Agron.*, 1930, **22**, 453.
2. Hall, D. M., *Tech. Bull. Minnesota Agr. Expt. Sta.*, 1934, 103.
3. Koehler, B., Dungan, G. H. and Holbert, J. R., *Illinois Agricultural Experiment Station Bull.*, 1925, 266.
4. Huber, L. L., *Science for the Farmer*, 1953.
5. Shank, D. B., *J. Am. Soc. Agron.*, 1943, **35**, 976.

### A NEW SPECIES OF *PHYLLOSTICTA*

DURING the study of the fungus flora of Jabalpur the author encountered a leaf spot on *Alangium lamarckii* Thw. The disease first appears as small ash-coloured spots on any part of the leaf. At advanced stage lesions become circular to irregular and change to brown colour.

Lesions may coalesce. Midrib and the chief veins are freely traversed.

Examination of the lesions revealed the pathogen to be a *Phyllosticta* (Fig. 1).

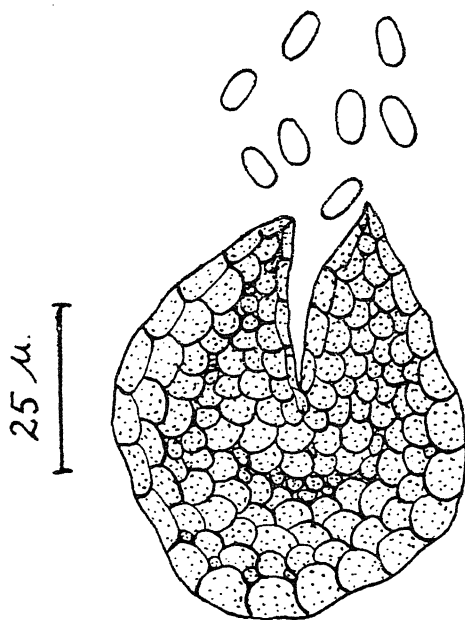


FIG. 1. *Phyllosticta alangii*—Pycnidia with conidia.

Pycnidia brown, superficial, globose to subglobose, 45–156  $\mu$  in diameter; conidia hyaline, single celled, ovoid to cylindrical, 11.3–23  $\times$  3.3–6.6  $\mu$ .

The specimen was examined by Mr. Deighton, Assistant Mycologist, Commonwealth Mycological Institute, Kew, England, who reports that "very few fungi have been described on *Alangium*". So far there is no record of *Phyllosticta* on any species of *Alangium*. It is, therefore, being presented here as a new species; *Phyllosticta alangii*.

*Phyllosticta alangii* HASIJA SP. NOV.

Pycnidia brunnea, superficiales, globosa vel subglobosa, diametentia 45–156  $\mu$ ; conidia hyalina, semel cellulata, ovalia vel cylindrica, 11.3–23  $\times$  3.3–6.6  $\mu$ .

In foliis viventibus *Alangii lamarckii* Thw. ad Jabalpur in India, mense martio anni 1961, leg-Hasija.

The type specimen has been deposited in the Commonwealth Mycological Institute, Kew, Herbarium No. 85349 (b).

The author expresses his grateful thanks to Dr. G. P. Agarwal, for his guidance, to Dr. J. C. F. Hopkins, Director, Mr. Deighton,

Assistant Mycologist, Commonwealth Mycological Institute, Kew, England, for help in the identification of the species.

Department of Botany,  
Govt. Science College,  
Jabalpur, September 4, 1962.

S. K. HASIJA.

### PRIMARY PRODUCTION IN THREE UPLAND LAKES OF MADRAS STATE, INDIA

VERY little information is available on primary production in fresh-water lakes, especially in this part of the World. Rodhe<sup>1</sup> has given an account of production in Swedish lakes and Verduin<sup>2</sup> furnished data on photosynthesis by phytoplankton communities in L. Ohio and L. Erie. Eise<sup>3</sup> has worked out the productivity of fish ponds in Malaya. Rodhe<sup>1</sup> is of opinion that classification of Lakes based on "..... trophic" typing is misleading and that a better procedure would be to determine the primary production in these lakes. A detailed study of the physico-chemical condition of three cold-water lakes in tropical area has been made by the author<sup>4</sup> and the present data indicate a correlation between the lake typology and primary organic production. Organic production was estimated from oxygen production in light and dark bottles, at various depths. The results were calculated per unit area, i.e., m<sup>2</sup>.

The results obtained for one occasion are presented in Table I. The yields appear to be

very high, especially in the case of Ooty Lake and to a lesser extent in Yercaud Lake. Kodaikanal Lake shows the lowest production among the three lakes. Its low pH value, very low conductivity, the high transparency, low plankton volume, dominance of desmids and absence of nutrients-phosphate and silicate mark it out as 'oligotrophic'. Carbon assimilation in this lake is the lowest noted so far by us in any water. Production was greater in Yercaud Lake, which is considered to be turning "eutrophic"—this is a slightly polluted lake with a bloom of *Microcystis aeruginosa*. The high pH value of 8.6 is indicative of high degree of photosynthetic activity. Only this lake shows phenolphthalein alkalinity at times, indicating the complete use up of free carbon dioxide. The phosphate and silicate content and other physico-chemical conditions are more favourable for productivity than in Kodaikanal lake. The plankton volume was high and the sechi disc reading low.

It is however the Ooty Lake which, though situated at a high altitude of 2,500 m. and having a cold climate, shows a very high level of primary production, even far exceeding those of other tropical ponds and reservoirs examined (Sreenivasan, unpublished). This also exceeds the maximal photosynthetic rates instanced by Verduin.<sup>2</sup> This lake has become so eutrophic as to become 'senescent'. However this lake differs from the Yercaud Lake in having a low

TABLE I

Date	Lake	Elevation above sea level m.	Organic production gross C./m. <sup>2</sup> /day grams	Dominant plankton species
May 1962	Ooty Lake 'C' section	.. 2500	6.209	<i>Synecrypta</i> , <i>Anabena</i> , <i>Microcystis</i>
	" 'B' "	..	11.023	Vol. 0.2 c.c./L.
July 1962	Yercaud Lake	.. 1340	3.113	<i>Microcystis</i> , <i>Melosira oscillatoria</i>
				Vol. 0.7-0.8 c.c./L.
May 1962	Kodaikanal Lake	.. 2285	0.750	<i>Batryococcus ceratium staurastrum</i>
				Vol. 0.02 c.c./L.

Physico-Chemical Conditions

Date	Lake	Temperature 0°	pH	Electrical conductivity mhos	Hardness p.p.m. CaCO <sub>3</sub>	Sechi disc. visibility m.	Compensation depth m.	SiO <sub>2</sub> mg./L.	P <sub>2</sub> O <sub>5</sub> mg./L.
May 1962	Ooty Lake 'C' section	.. 21.8	6.9-7.1	207	68.0-74.0	0.30	2.5	..	..
	" 'B' "	.. 20.3-23.0	7.1	207	68.0-74.0	0.50	2.0	0.4	0.04
July 1962	Yercaud Lake	.. 22.0-22.4	8.6	130	47.0-70.0	0.55	1.5	0.8	0.04-
May 1962	Kodaikanal Lake	.. 20.4-22.4	6.1-6.8	25	8.0-16.0	3.5	2.0	0.02	0.08-0.00

pH value and in not developing phenolphthalein alkalinity which means that free carbon dioxide is not fully used up. In this lake oxygen depletion occurs below a depth of 2.5 to 3.0 m., which is due to reducing activities. The production reported herein for Ooty Lake of 84.0 acres area, appears to be very high; exceeded only by few other waters studied by us in plains. Similar high yields have been obtained for this lake and for Yercaud Lake on subsequent occasions (unpublished results).

The primary organic production reported herein correlates well with physico-chemical factors, biological conditions and could be used to classify lakes. The eutrophic, organically polluted Ooty Lake shows high organic production. The high oxygen deficit further confirms the 'eutrophic' nature of this Lake. Yercaud is less productive than Ooty Lake but still the yields are high. The oligotrophic Kodaikanal Lake has lowest primary production. Rodhe<sup>1</sup> feels that 100 mg. C/m.<sup>2</sup>/day could be the limit between oligotrophy and eutrophy. When considering Kodaikanal Lake, this appears to be too low. The occurrence of *Cyanophyceae* seems to go well with high productivity. Fish production in Ooty Lake averages 65 lbs./acre/annum while in Yercaud Lake it is 23 lb./acre/year and in Kodaikanal Lake it is very low—4 lb./acre/year. I am indebted to Miss. Felicy Antony for the identification and enumeration of plankton.

Freshwater Biological Station, A. SREENIVASAN.  
Hydrological Section,  
Bhavanisagar,  
October 29, 1962.

1. Rodhe, W., *Verh. internat. ver. Limnol.*, 1958, **13**, 121.
- , *Rapp. Proc. Verh.*, 1958, **144**, 122.
2. Verduin, J., *Ecology*, 1959, **40**, 377.
3. Fish, G. R., *Proc. Centenary. Bicentenary Cong., Biology, Singapore Uni.*, Malaya Press, 1960, p. 18.
4. Sreenivasan, A., *Madras Fisheries Station Reports and Year Book*, April 1957 to March 1958 (1962), 139.

#### NOTE ON ENDOGENOUS FLOWERS IN *CARICA PAPAYA* LINN.

In the present note, an interesting case of endogenous flowers in *Carica papaya* Linn. is recorded for the first time. The endogenous flowers were detected inside a fruit of *Carica papaya*, when cut open, which otherwise looked normal. It was seen as a large, creamy white, thick, fleshy and soft structure, attached to the inner wall of the fruit parietally by means of a small knob-like attachment portion at its base (Fig. 1). On a careful examination, this was

seen to consist of a massive almost oblong and deeply furrowed portion and a comparatively smaller, cylindrically oblong finger-like lateral portion. The larger one measured 8.5 cm. long and 3 cm. broad at its broadest part, while the latter one measured about 4 cm. long and 0.5 cm. broad only.

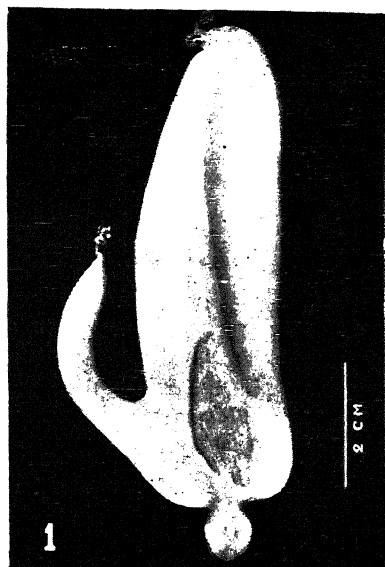


FIG. 1. Photograph of adventitious female flowers formed endogenously within the chamber of the fruit of *Carica papaya* Linn.

The larger structure was again seen to be the result of lateral fusion of two more or less similar bodies for their whole length except for their very extreme tip portions.

The extreme tip portions of all these bore each free stylar-like organs, as in the normal female flowers. A cross-section of the relatively thicker massive structure showed a central chamber running to a greater part of its length and bore very minute ovule-like bodies attached parietally as in normal ovaries. The entire structure seen inside the fruit of *Carica papaya* would thus appear to correspond to a female inflorescence, in a simple cyme, without free petals, but with only the ovaries, and the ovaries of two adjoining flowers being fused almost to their whole length. It would thus appear that this is an instance of adventitious female flowers without petals, being formed endogenously within the fruit in the place of some of the ovules in the ovary.

Industrial Section,  
Indian Museum,  
Botanical Survey of India,  
Calcutta-13, September 13, 1962.

K. S. SRINIVASAN.  
R. B. BOSE.

# **VAVILOVOID MUTANT IN TRITICUM AESTIVUM AND THE ORIGIN OF *T. VAVILOVI***

WHEN varieties of bread wheat (*Triticum aestivum* L.,  $2n = 42$ ), are treated with mutagens, a high viable mutation rate coupled with a narrow mutation spectrum is observed.<sup>1,2</sup> Among the viable mutations, speltoids having lax ears, rigid and strongly keeled glumes and invested kernels are the most common. These are known to arise from the deletion or inactivation of the free-threshing gene *Q* located in the long arm of chromosome 5A.<sup>1</sup> While examining the  $M_2$  families of the bread wheat variety C-281 derived from X-ray (dry seeds treated with 16 Kr.) and Ethyl methane Sulphonate treatments (seed soaked in 280 p.p.m. EMS for 18 hours), we found two plants (one in each treatment) with spikes presenting a branched appearance due to an increase in the length and number of nodes of rachillae in all the spikelets. The elongation of rachillae led the arrangement of the florets of a spikelet in 2 to 3 tiers (Fig. 1). These characteristics are specific to the hexaploid species *T. vavilovi* Jakub. Similar *vavilovoid* mutants have been

reported earlier in the tetraploid ( $2n = 28$ ) species *T. carthlicum*<sup>3</sup> and *T. durum*.<sup>4</sup>

Both the *vavilovoid* mutants found in *T. aestivum* occurred in lines segregating for speltoids and both were characterised by the loss of the free-threshing habit. Rachilla elongation was not found in any plant possessing the speltoid suppressor gene *Q*. Though not explicitly stated, it is clear from the descriptions of the *vavilovoid* mutations isolated in *T. carthlicum*<sup>3</sup> and *T. durum*<sup>4</sup> (both are free-threshing species) that such mutants are simultaneously also speltoid. Other changes observed in the *vavilovoid* mutants of C. 281 were slender culm, increased waxiness, basal sterility of the type found in speltoids by Frankel and Fraser<sup>5</sup> and a reduced length of awns. Awning started from the basal spikelet but the longest awn in the mutant was only 1.8 cm. in length while the corresponding length in the parent strain was 8.6 cm. Though derived from entirely different treatments, the two *vavilovoid* mutants were phenotypically identical, suggesting that the same chromosome segment might have been affected.

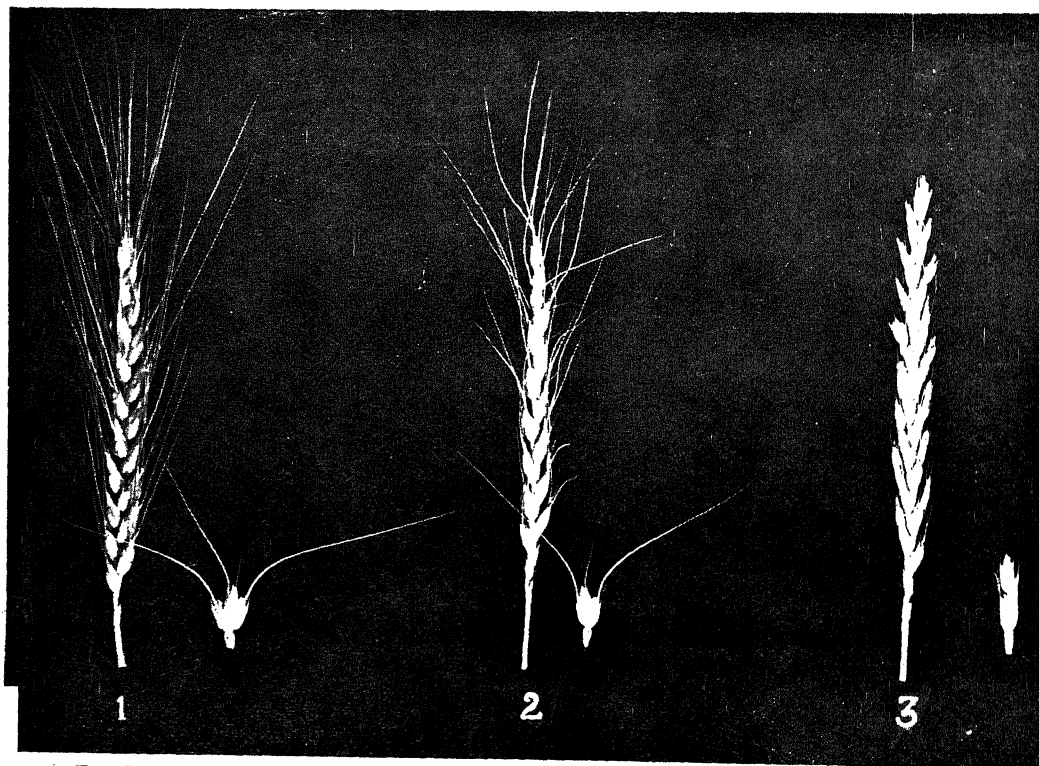


FIG. 1. Ear and spikelet of (1) *T. aestivum* var. C. 281; (2) speltoid mutant and (3) *vavilovoid* mutant.

The *vavilovoid* mutants bred true for all the altered characteristics.  $M_3$  progenies were raised from 5 hetero- and 5 homo-speltoids isolated in the  $M_2$  family (X-ray treatment) in which the *vavilovoid* mutant occurred. The homo-speltoids gave rise only to speltoids, while one hetero-speltoid family contained 21 free-threshing (parent type), 64 speltoid and 7 *vavilovoid* plants. The *vavilovoid* types were also speltoid and thus the segregations for speltoidy and *vavilovoidy* follow the 3 : 1 (3 speltoid : 1 free threshing) and 15 : 1 (15 normal rachilla : 1 elongated rachilla) ratios respectively. These data indicate that Q suppresses *vavilovoid* expression and that in free-threshing *Triticum* species, mutations simulating *T. vavilovi* can occur only in conjunction with speltoidy.

Jakubziner,<sup>6</sup> who first found *T. vavilovi* in the foot-hills of Armenia (U.S.S.R.), gave it specific status on the basis of its distinct morphological traits. Since the chromosomes of *T. aestivum* and *T. vavilovi* are homologous and since they cross readily yielding fertile hybrids and straightforward segregations,<sup>7,8</sup> Sears<sup>9</sup> has classified *vavilovi* as a sub-species of the collective species *T. aestivum*. Isenbeck and Rosenstiel<sup>10</sup> suggested that *vavilovi* might have arisen as a single-step mutation from *T. aestivum*. The present data would suggest that *vavilovi* could have arisen as a recessive mutation either in sub-species *spelta* or in a speltoid form of sub-species *vulgare* of *T. aestivum*. That the latter origin is more likely is suggested by *vavilovi* possessing a tough rachis as in *vulgare* and not a brittle one as in *spelta*. It is not clear whether the elongate rachilla character confers any adaptive advantage in the Transcaucasian region, since this mutation seems to have survived in nature only there. The *vavilovoid* mutation is of no interest in wheat breeding in view of the coincident loss of the free-threshing habit and expression of various forms of spikelet sterility.

Division of Botany, M. V. PRABHAKARA RAO.  
Indian Agricultural M. S. SWAMINATHAN.  
Research Institute,  
New Delhi-12, November 2, 1962.

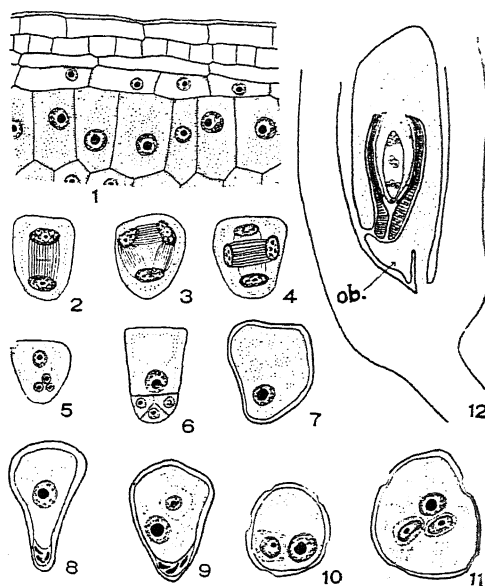
1. MacKey, J., *Hereditas*, 1954, **40**, 65.
2. Natarajan, A. T., Sikka, S. M. and Swaminathan, M. S., *Proc. 2nd Int. Conf. Peaceful Uses of Atomic Energy*, 1958, **27**, 321.
3. Barabas, Z., *Nature*, 1959, **183**, 1349.
4. Scarascia, G. T., D'Amato, F. and Bozzini, A., *Atti, A.G.I.*, 1961, **6**, 371.
5. Frankel, O. H. and Fraser, A. S., *Heredity*, 1948, **2**, 391.
6. Jakubziner, M., *Prirodo* (U.S.S.R.), 1933, **11**, 72.

7. Sachs, L., *Jour. Agr. Sci.*, 1953, **43**, 204.
8. Singh, H. B., Anderson, E. and Pal, B. P., *Agron. J.*, 1957, **49**, 4.
9. Sears, E. R., *Hauub. Pflanzenzucht.*, 1959, **2**, 164.
10. Isenbeck, K. and Rosenstiel, K., *Ibid.*, 1950, **2**, 289.

MALE GAMETOPHYTE AND  
OBTURATOR IN *CYPERUS ROTUNDUS*  
L., AND *C. TRICEPS* ENDL.  
(=*KYLLINGA TRICEPS* ROTTB.)

EMBRYOLOGICALLY, Cyperaceae has been worked out inadequately. Male gametophyte shows features of special interest and this has attracted the attention of Juel,<sup>1</sup> Stout,<sup>2</sup> Piech,<sup>3</sup> Tanaka,<sup>4,5</sup> and others. In the present study, I have tried to elucidate some of the inaccurate observations recorded by the previous workers on the family.

In *Cyperus rotundus* and *C. triceps* the anthers are tetralocular. Microspore mother cells are surrounded by a four-layered wall consisting of epidermis, endothecium, a middle layer and glandular tapetum (Fig. 1). The nucleus of



FIGS. 1-12. (Figs. 1-4, 6, 8, 9, 11 are of *Cyperus rotundus*; rest of *C. triceps*.) Fig. 1. L.S. A part of anther, microspore mother cells and wall layers. Figs. 2-4. Meiosis I, II; tetrahedral and decussate arrangement. Fig. 5. Microspore mother cell; four nuclei, one enlarged. Fig. 6. Same, one functional and three non-functional microspores. Figs. 7, 8. Pollen grains, uninucleate. Figs. 9, 10. Same, 2-celled; note degenerated microspores in Figs. 8, 9. Fig. 11. Same, 3-celled. Fig. 12. L.S. Ovule showing fanular obturator. ob, Obturator.

the microspore mother cell divides simultaneously resulting into tetrahedrally and decussately arranged microspore nuclei (Figs. 2-4). Cytokinesis is lacking and the nuclei of the microspore tetrad remain close together at the centre of the microspore mother cell. One of these becomes prominent and develops further while the rest, smaller and non-functional, are destined to degenerate. These are pushed towards the periphery of the mother cell (Fig. 5). A cleavage furrow, accompanied by a cell plate, ultimately separates this group of three nuclei from the functional microspore nucleus. Similar walls, though less prominent, are also formed, in between the non-functional microspore nuclei, separating them from each other (Fig. 6). The non-functional microspores degenerate but their remnants persist in two-celled pollen grains of *C. rotundus*. Remnants of the non-functional microspores in *C. triceps* disappear rather early, not visible even in uninucleate pollen grains.

Pollen grains are nearly spherical in *C. triceps* (Fig. 7); pear-shaped in *C. rotundus* (Fig. 8). It develops to form the vegetative and the generative cells. The prominent vegetative nucleus occupies a more central position in *C. rotundus*; peripheral in *C. triceps*. The generative cell lies close to the vegetative nucleus and a distinct hyaline cytoplasm surrounds its nucleus (Figs. 9, 10).

Shedding stage of pollen grain is three-celled in *C. rotundus* (Fig. 11).

The ovule in both the plants is anatropous, bitegmic and crassinucellate. During the curvature of the ovule, a swelling appears on the funiculus and grows further to cover the micropyle like a canopy probably acting as an obturator (Fig. 12). It persists up to the globular stage of the embryo in both the species.

The author wishes to express her thanks to Prof. P. Maheshwari for suggesting the problem, Dr. B. Tiagi for valuable discussions and Prof. C. V. Subramanian for encouragement.

Department of Botany, PUSHPA KHANNA.  
University of Rajasthan,  
Jodhpur, August 14, 1962.

1. Juel, H. O., *Jahrb. f. wiss. Bot.*, 1900, **35**, 626.
2. Stout, A. B., *Arch. F. Zellforsch.*, 1912, **9**, 114.
3. Piech, K., *Bul. Internatl. Acad. Polonaise Sci. et Lettr.*, 1928 ( $\frac{1}{2}$ ), 1.
4. Tanaka, N., *Cytologia*, 1940, **10**, 348.
5. —, *Bot. Mag. (Tokyo)*, 1941, **55**, 35.

## LOCATION OF THE GENE FOR LEAF MARGIN DENTNESS IN BARLEY

IN the course of recording observations on hairiness of leaf-blade in the segregating populations of the cross E. 406  $\times$  C.I. 2256, by rubbing the finger-tip over the leaf-blade just after the complete ear-emergence of the crop, it was noticed that in some plants the stout band of thickened tissue on leaf margin was serrated, while in others it was smooth. Subsequent examination of leaf margins of a number of plants of the parental varieties and the segregating populations with the help of 10-X hand lens revealed that the leaf margins of E. 406 are denticulate with silicified teeth, while in C.I. 2256 the thickened sinus wall is devoid of such teeth. The  $F_2$  and  $F_3$  populations showed clear cut segregation for this character. Two classes, viz., the presence or absence of dents on the leaf margin were; therefore, recognised in classifying the segregating populations. Out of a total of 281  $F_2$  plants under study, 211 were dented and 70 were smooth, showing a good fit to a ratio of 3 dented: 1 smooth. In the  $F_3$  generation, out of 99 families studied, 25 were homozygous for dented leaf margin, 53 segregated for dentness and 21 were homozygous for smooth leaf margin, as expected on 1:2:1 ratio, confirming thereby that the inheritance of this character is governed by a simple Mendelian factor pair.

The linkage relationship of this character was studied in the  $F_2$  and the  $F_3$  generations with the marker genes  $N-n$ , for hulled *vs.* naked caryopsis and  $R-r$  for rough *vs.* smooth awns in linkage groups III and V respectively. The parent E. 406 was rough awned and had naked caryopsis, while C.I. 2256 was smooth awned with hulled caryopsis. The data of joint segregation for these characters are given in Table I.

It would be observed that dented *vs.* smooth leaf margin was inherited independently of  $Nn$  but showed complete linkage with  $Rr$ , indicating its presence in linkage group V. This complete linkage between leaf margin, dentness and lemma awn bariness, in coupling phase, however, was either due to the action of the same gene in controlling the development of dents on leaf margins and barbs on lemma awns or that there was a very tight linkage between the two different genes so that no recombinations were obtained in the existing population.

Preliminary data collected on the pattern of distribution of the dents along the leaf margin on some foreign barley varieties revealed that

TABLE I

(a)  $\chi^2$  Test of independence for various joint segregations, from  $F_2$  data

Dented vs. smooth leaf margin	Number of $F_2$ plants			
	Hulled vs. naked caryopsis		Lemma awn barbness	
	Hulled	Naked	Rough	Smooth
Dented ..	161	48	211	0
Smooth ..	49	18	0	70

 $\chi^2 = 0.4245$  P. Value =  $0.50-0.70$  Absolute linkage(b)  $\chi^2$  Test of independence for various joint segregations, from  $F_3$  data

Dented vs. smooth leaf margin	Number of $F_3$ families					
	Hulled vs. naked caryopsis			Lemma awn barbness		
	Hom. hulled	Segre- gating	Hom. naked	Hom. rough	Segre- gating	Hom. smooth
Hom. dented ..	7	11	7	25	0	0
Segregating ..	12	24	17	0	53	0
Hom. smooth ..	3	11	7	0	0	21

 $\chi^2 = 1.3068$  P. value =  $0.80-0.90$  Absolute linkage

the different varieties can be broadly grouped in to the following five classes depending on the spread of dents.

- Margins denticulate from tip of the base of leaf blade.
- Margins denticulate from tip to the upper three-fourth portion of leaf blade.
- Margins denticulate from tip to the upper half portion of leaf blade.
- Margins denticulate from tip to the upper one-fourth portion of leaf blade.
- Margins smooth.

This varying nature of distribution of dents on the leaf margin presents some evidence that in addition to the main factor controlling the expression of this character, there are some other factors which control the distribution pattern.

Division of Botany, K. B. L. JAIN.  
Indian Agri. Res. Institute, M. K. UPADHYAY.  
New Delhi-12, August 11, 1962.

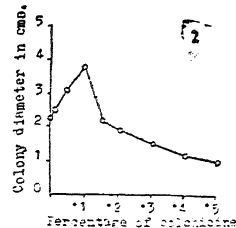
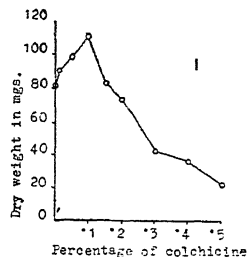
### EFFECT OF COLCHICINE ON THE GROWTH AND SPORULATION OF *ALTERNARIA TENUIS* NEES EX. PERS.

COLCHICINE is known to cause chromosomal aberrations and changes in growth or biochemical characteristics of plants.<sup>1-4</sup> Comparatively very little work has been done with respect to

fungi. Stimulated growth in yeast (Richard<sup>5</sup>) and increase in penicillin yield (Gordon and McKechnie<sup>6</sup>) have been attributed to polyploidy or chromosomal aberrations as a result of colchicine treatment. Studies on the growth, and sporulation of *Alternaria tenuis* Nees ex. Pers. (isolated from *Brassica campestris* L. leaves) treated with colchicine were made and are reported here.

One per cent. aqueous colchicine solutions (Seit-filtered) were added to Czapek-Dox agar (pH 7.5) after autoclaving, in order to bring the final percentage of colchicine to 0.01, 0.05, 0.1, 0.15, 0.2, 0.25, 0.3, 0.4, and 0.5. Three replicates of each treatment were prepared and the cultures were incubated at  $26 \pm 1^\circ \text{C}$ . Colony diameter and dry weight were determined on the fifth and seventh day of incubation respectively. Strain of *A. tenuis* used in this investigation has been deposited in the Commonwealth Mycological Institute, Kew, Surrey, England, under reference No. I.M.I. 92691.

Colony diameter and dry weight increased up to 0.1% colchicine concentration above which they showed a sharp decline (Graphs 1 and 2). At 0.3% and above the colony exhibited zonate appearance, the outer zone being greenish-black and the inner whitish in colour. The zonation was accompanied by abundance of aerial hyphae.

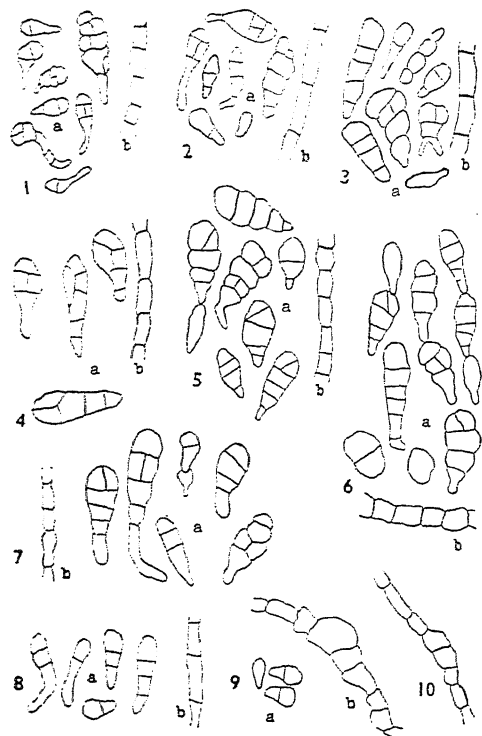


GRAPHS 1-2. Graphs showing relationship between percentage of colchicine in the medium and dry weight of the fungus (Graph 1) and colony diameter (Graph 2).

Results show that a direct relationship exists between the average distance between two septa of the hyphae and its growth rate. The growth and distance between two septa which was maximum at 0.1% colchicine level, generally decreased at higher concentrations.

Sporulation also increased with increase in colchicine concentration up to 0.1%, beyond which there was a sharp decline followed by complete suppression at 0.5%. Size of spores increased up to 0.25% colchicine concentration, although they showed a tendency for reduction in the number of constituent cells. At 0.3 and 0.4% colchicine levels small one- or two-celled

spores were commonly formed. At 0.5% the sporulation was altogether suppressed and the hyphae became irregular, distorted and at times swollen (Figs. 1-10).



FIGS. 1-10. *Alternaria tenuis* Nees ex Pers. Spores (a) and hyphae (b) grown on Czapek-Dox agar at 26° C., with various concentrations of colchicine in the medium. Fig. 1. Control, 11%. 2. 0.01%, 3. 0.05%. Fig. 4. 0.1%, 5. 0.15%, 6. 0.2%, 7. 0.25%, 8. 0.3%, 9. 0.4%, 10. 0.5%. All figures,  $\times 400$ .

Percentage spore germination also declined with increase in colchicine concentration. No permanent saltants were produced as a result of this colchicine treatment.

The authors are grateful to Dr. J. C. F. Hopkins and Dr. M. B. Ellis for helping in the specific identification of *Alternaria tenuis*.

Microbiology Laboratory, J. N. RAI,  
Botany Department, A. K. SINGH,  
Lucknow University, Lucknow, July 30, 1962.

\*1. Blake-lee A. F., *C.R. Acad. Sci., Paris*, 1938, 205, 476.

\*2. Dustin, A. P., Havas, L. et Iits, F., *C. R. Acad. Sci. Paris*, 32nd Reun. a Marseille, 1937, 32, 170.

3. Eigiti O. J. and Dustin P., *Lloydia*, 1947, 10, C5.

4. — and —, *ibid.*, 1949, 12, 185.

5. Gordon, W. and McKechnie, J., *Lancet*, 1945, 249, 47.

6. Richards, O. W., *Jour. Bact.*, 1933, 36, 47.

\* Original not seen.

## EVIDENCE OF SEX REGULATING PROPERTY OF ASAFOETIDA IN SOME MONOECEIOUS CUCURBITS

DIFFERENT views prevail as to the sex suppression and sex reversal in plants.<sup>1-4</sup> With a view to test the validity of the efficacy of Asafoetida in promoting the production of female flowers in cucurbits, a preliminary trial was conducted on bottlegourd (*Lagenaria siceraria*) and pumpkin (*Cucurbita moschata*) with the following treatments:

1. Insertion of 70 mg. of Asafoetida grains in a slit in stem, cut about 2" above ground level;
2. Spray with 0.1% solution of Asafoetida, twice before blooming; and
3. Control.

The data recorded are given in Table I.

TABLE I  
Effect of Asafoetida on flower sex ratio

Crop	Plant No.	No. of flowers					
		Control		Asafoetida inserted		Asafoetida sprayed	
		Female	Male	Female	Male	Female	Male
1. Gourd ..	1	26	204	64	252	34	273
	2	13	96	151	489	80	197
	3	140	661	..	58	3	21
	4	4	91	..	..	10	77
	Total sex-ratio	153	1052	234	799	127	578
		1 : 5.7		1 : 3.4		1 : 4.5	
2. Pumpkin	1	3	32	8	26	10	45
	2	15	66	43	181	43	96
	Total sex-ratio	18	128	51	207	53	141
		1 : 7.1		1 : 4.1		1 : 2.7	

The data suggest a marked female tendency in plants treated with Asafoetida. The first male flower usually appeared on the 4th or 5th and 6th to 8th node; and the 1st female flower appeared on the 7th to 12th and 14th to 19th node, in gourd and pumpkin respectively.

One of the most striking observations in pumpkin was the blooming of the female flower at the 14th node ahead of the male flowers in one of the treated plants.

The authors deeply appreciate the facilities provided by the Botany Section of the Institute.

Government Agril. College and H. R. KALIA,  
Research Institute, R. S. VASUDEVA,  
Ludhiana, September 10, 1962. S. P. BHARTI.

1. Howlett, F. S., *Annals of Botany*, 1926, 50, 767.

2. Nir ch, J. P., et al., *Am. J. Bot.*, 1952, 39, 12.

3. Chaudhri, R. S. and Pathak, S. C., *Indian J. Hort.*, 1959, 16, 162 and 233.

4. Shliss, O., *Science*, 1961, 33, 2061.



## REVIEWS

**Handbuch Der Kolorimetrie, Band I. Kolorimetrie in Der Pharmazie.** By B. Kakac and Z. J. Vejdelek. (Veb Gustav Fischer Verlag, Jena), 1962. Pp. ix + 1139 with 56 Diagrams and 12 Plates. Price D.M. 79.20.

It is needless to emphasize the importance of maintaining quality control in the pharmaceutical industry. The confidence of the consumer in the drug quality has been rudely shaken recently on account of the spurious preparations that have been flooded in the market. The assessment of each product that is delivered out of the manufacturing concern is an imperative need of the day.

The quantitative estimation of the ingredients and also of the foreign materials (impurities, bases, fillers, etc.) present in the drug is unusually difficult. Trace analysis becomes essential even for the routine evaluations. Spectrophotometry has become an indispensable tool for such purposes. It has become obligatory even to a technician to learn about the elements of the theoretical principles and the instrumentation.

The book under review is the first volume among the projected series of volumes to cover the entire world literature in the field, which has accumulated over a long period. These volumes are intended more as a standard ready reference work rather than as a text-book.

The first part of the book contains a brief historical survey, and deals with fundamental laws governing the photometric methods. Both visual photometry and objective photometry have been critically discussed. Limitations and errors involved in the photometric procedures are assessed. Details of the experimental techniques are also included in this unit.

Part II deals with the actual photometric methods as applied to specific cases such as:

- (1) Alkaloids (aliphatic, aromatic, pyridine-, quinoline-, isoquinoline, pyrrolizidine-, indole-, imidazole-, and tropane-alkaloids).
- (2) Glycosides and Aglycones (e.g., Salicin, Arbutin, Gentiopikrin, etc.).
- (3) Plant Products (Pinene, Azulene, Menthol, Thymol, Carvacrol, Citral, etc.).
- (4) Vitamins (A, D, E, K, B, C).
- (5) Antibiotics (e.g., Penicillin, Tyrothricin, Streptomycin, Novobiocin, etc.).

The value of the book is very much enhanced by the inclusion of references to original papers under estimation. The details of the procedure along with the list of reagents required are presented for every component to be estimated. The book is provided with author index and subject index. The inclusion of an index giving all the synonyms of the names of chemicals and the common trade names is very valuable. It is refreshing to see photographs of standard instruments manufactured in England (Adam Hilger) and America (Coleman), in addition to those manufactured by the famous Karl Zeiss (JENA) of Germany and Firma Laboratories, Prague.

The book (1253 pages) will be very valuable in any Pharmaceutical Laboratory and all the chemists and druggists should be grateful to the two Czechoslovakian authors for presenting this valuable ready reference book. We eagerly look forward to see the other volumes, II and III, in the series before long.

A. R. V.

**Reports on Progress in Physics** (Vol. XXV). (The Institute of Physics and the Physical Society, London, S.W. 1), 1962. Pp. 529. Price £ 4/4 sh.

The latest volume of *Reports on Progress in Physics* for 1962 contains eleven review articles the subjects of which range from nuclear reactions to satellite orbits.

Magnetohydrodynamics is the study of the motion of electrically conducting fluids in a magnetic field. When applied to ionized gases under low pressure it covers plasma physics whose importance has come to the forefront in recent years with the possibility of producing controlled nuclear fusion in the laboratory. The publication of the most outstanding book on the subject—"Hydrodynamic and Hydro-magnetic Instability" by S. Chandrasekhar—is sure to give a new impetus to theoretical researches in the various aspects of magnetohydrodynamics, which in turn will have their impact on the practical solution of the controlled nuclear fusion problem. The article by T. G. Cowling on Magnetohydrodynamics in this *Report* lays stress on the theoretical aspects of the subject and the discussion includes interplanetary magnetic fields and geomagnetic storms.

The article on "Health Physics" by G. W. Dolphin, W. J. Megaw and J. Rundo is the first one to appear on this subject in these Reports. It deals with problems of biological hazards of radiation exposure of personnel working in nuclear and atomic energy establishments. The section on aerosols deals with the release, dispersion and deposition of radioactive materials, especially iodine, which may possibly occur as a result of a reactor accident.

In the article "Mossbauer Effect", A. S. F. Boyle and H. E. Hall review the new phenomenon of recoilless emission and resonant absorption of low energy gamma-rays by solids, and the successes that have been so far achieved by the application of this effect in solid state and nuclear physics.

Observations made from above the atmosphere with the aid of balloons, rockets and satellites have marked the beginning of a new era in astronomical studies. By eliminating the absorption in the earth's atmosphere these techniques have enabled the study of the full spectrum of the Sun and the energy distribution of solar radiation down to about 84 angstrom. These results and the results of the coronal X-ray emission by rocket observations have been discussed by H. Friedman in the article "Solar Observations obtained from Vertical sounding".

As long ago as the early twenties considerable work on the diffraction of liquids by X-rays was done first by Debye *et al.* and later by Raman and his school. Elucidation of structure of molecules by X-ray diffraction studies depends on the correct understanding of what is known as the radial distribution function (RDF) or the probability function of molecules around each individual molecule in the liquid. Zernike and Prins who applied the Fourier intergral theorem to evaluate RDF, have laid the theoretical foundations for interpreting liquid diffraction patterns. Since then many efforts have been made on liquid structure studies by X-ray diffraction. The recent application of thermal neutron diffraction techniques has added importance to the subject. In the article on "Radial Distribution Curves by Diffraction" K. Furukawa reviews some of the results of recent experiments on monatomic, diatomic and polyatomic liquids, liquid alloys, water and aqueous solutions, ionic liquids, molten oxides and glasses.

Nuclear reactions with oriented target nuclei is a promising field of experimental physics. Though the potentialities of this method are

well recognised not much work has been done because of the various experimental difficulties involved in the method. The article on "Nuclear Reactions with Oriented Target Nuclei and Polarized Beams" by J. M. Daniels and J. Goldemberg gives an appraisal of this method, and discusses in particular, methods by which nuclei can be oriented, which particular nuclei and in which media orientation can be effectively achieved, and the sources of polarised and partially polarised particles suitable for nuclear reaction.

The other articles in the Reports are: "The Cohesive forces in Metals and Alloys" by N. F. Mott; "Dispersion Relations in Strong-coupling Physics" by S. Mandelstam; "Geophysical Results obtained from Satellite Orbits" by G. E. Cook; "Shock Waves in Gases" by H. J. Pain and E. W. E. Rogers; "Superconductivity Switching" by J. M. Lock.

A. S. G.

#### Developments in Applied Spectroscopy (Vol. I).

Edited by W. D. Ashby. (Plenum Press, 227, West 17th Street, New York 11, N.Y.), 1962. Pp. x + 260. Price \$ 9.00.

This volume contains the Proceedings of the Twelfth Annual Symposium on Spectroscopy, held in Chicago, on May 15-18, 1961.

The use of spectroscopic techniques in industries has made enormous progress in recent years. The tools of automation in industrial processes call for rapid and precise analytical data at every stage of production. In steel industry, for example, more rapid analysis of the melts at preliminary furnace stage assures not only a better quality of steel but also an increased output.

Instruments like photoelectric spectrometers and vacuum X-ray spectrometers play a vital role in the analysis of melts and raw materials in steel and allied industries. Advances in these techniques are based on experience gained in industrial laboratories all over the world.

The Symposium on Spectroscopy forms a useful forum for spectroscopists to meet annually and discuss their results and exchange ideas and information. Over the twelve years this annual meeting has grown in size and importance, and the contribution it makes to an understanding of the latest developments in the various fields of applied spectroscopy has been well recognized.

It must be pointed out, however, that many important papers presented and discussed at the earlier meetings remain, more or less, lost

for further reference for want of suitable publication. In this context it is a welcome idea that a start to publish the Proceedings in an easily available book form has been made, and W. D. Ashby, Co-ordinator of the Twelfth Symposium, deserves congratulations.

The volume contains twenty full papers and about an equal number of abstracts of papers presented at the 1961 symposium. These include papers on X-ray spectroscopy, ultra-violet and visible spectroscopy and infra-red and Raman spectroscopy. The contributors being from research laboratories attached to industries, the results presented by them will be of value to all practical spectroscopists engaged in special problems of research in these fields of investigation.

**The Many-body Problem.** Edited by E. R. Caianiello. (Academic Press, New York-3, N.Y.), 1962. Pp. xii + 344. Price \$10.50.

This volume contains the lectures on "many-body problems" delivered at the Second International Spring School of Physics held at the University of Naples in 1962, and is a sequel to the earlier volume entitled "Field Theory and the Many-body Problem" which covered the First Spring School held in 1961. It contains eighteen articles contributed by fifteen leading scientists working in this theoretical field of study. The scope of the Second School, unlike that of the first one, has been restricted to specific problems mostly on the theory of Fermi gases. This has led to a deeper treatment of many problems of growing interest concerning ground state properties, equilibrium properties at nonzero temperature and transport properties, of the systems studied. The timely publication of this book will be of benefit to all workers in this field especially those who did not have the opportunity to attend the International School.

**An Introduction to Mathematical Machine Theory.** By S. Ginsburg. (Addison-Wesley Pub. Co. Inc., Reading, Massachusetts, U.S.A.), 1962. Pp. ix + 148. Price \$8.75.

This book gives a treatment of selected topics on the behaviour of mathematical machines considered from the terminal-characteristics point of view, i.e., input sequences versus output sequences. The book is based on lectures given to classes which consisted of "programmers with an interest in the theoretical aspects of data processing, curious mathematicians, and

computer logical designers". The background knowledge needed on the part of the reader is the ability to follow elementary (but not necessarily simple) set-theoretic arguments.

The book contains four chapters respectively dealing with Complete sequential machines; Incomplete sequential machines; Abstract machines; and Recognition devices.

**Practical Chemistry—An Integrated Course.** By J. W. Buttle and D. J. Daniels. (Butterworth and Co. Pub. Ltd., 88 Kingsway, London W.C. 2), 1962. Pp. xi + 294. Price 21 sh.

This is a carefully thought-out and well written manual on practical chemistry to suit the changed requirements of syllabuses at the final High School level and for the G.C.E. (General Certificate of Education) examinations. It gives an integrated picture of the different aspects of practical chemistry and includes inorganic, physical and organic experiments, and qualitative and quantitative analyses.

The manual has been written with the maxim "practical work is the ideal basis for theoretical discussion, and the best experiments are those which are designed to illustrate principles as well as techniques".

The book is divided into three parts. In the first part, "Inorganic and Physical", the elements are taken in their groups according to the Periodic Table. The electron configurations of the atoms are given first, so that the students can at once realise the importance of the valency electrons as contributing to the chemical properties and reactions. Typical experiments relating to the most common elements in each group are described for performance and necessary inferences to be drawn by the student himself, with suggestions for further advanced work. The experiments include elements of paper chromatography, iodimetry and electrode potentials. Experiments on the Transitional Elements alone cover about 30 pages.

In the second part, "Organic and Physical," the chemistry of aliphatic and aromatic compounds are dealt with in a number of separate sections and the experiments in these include halides, aldehydes and ketones, primary amines and ethers.

The third part deals with elementary inorganic and organic qualitative analysis. The appendix includes over 200 G.C.E. examination questions.

Recently in England a Committee on Chemical Education was established sponsored by a

number of organizations including the Royal Society, the Royal Institute of Chemistry, and the Science Masters Association. One of the functions of the Committee is to coordinate the various developments that are taking place in chemical education and disseminate information on the new approach to the teaching of chemistry, especially at the High School level.

Thus the publication of this book as an integrated course in practical chemistry is timely, and will be welcomed not only in England but also overseas. Though intended primarily for Sixth Form and Ordinary National Certificate students in England, the book will find a wider appeal. In India it can be recommended for the teaching of chemistry in the Pre-university classes and the First year of the Engineering and Medical courses.

The printing and get-up of the book are Butterworths standard.

A. S. G.

**The Bacteria—A Treatise on Structure and Function—Vol. III. Biosynthesis.** Edited by I. C. Gunsalus and R. Y. Stanier. (Academic Press, N. York and London), 1962. Pp. xv + 718. Price \$ 19.50.

With this book, the third in the projected five-volume series on 'The Bacteria', the editors and publishers would have achieved a great deal by placing before the biologists and chemists alike all that is known and worth knowing about microorganisms and their chemical activities.

The scope and value of the volume may be easily gauged from the chapter titles and the contributors. They are: Photosynthesis and Lithotrophic Carbon Dioxide Fixation by S. R. Elsdén; Assimilation of Carbon Dioxide by Heterotrophic Organisms by H. G. Wood and R. L. Stjernholm; Inorganic Nitrogen Assimilation and Ammonia Incorporation by L. E. Mortenson; Pathways of Amino-Acid Biosynthesis by E. Umbarger and B. D. Davis; The Synthesis of Vitamins and Coenzymes by J. G. Morris; Biosynthesis of Purine and Pyrimidine Nucleotides by B. Magasanik; Tetrapyrrole Synthesis in Microorganisms by J. Lascelles; Synthesis of Polymeric Homosaccharides by S. Hestrin; The Biosynthesis of Homopolymeric Peptides by R. D. Housewright; Biosynthesis of Bacterial Cell Walls by J. L. Strominger; The Synthesis of Proteins and Nucleic Acids by E. F. Gale; and; The Synthesis of Enzymes by A. B. Pardee. The outcome is that the book meets a long-felt need for scientific data

previously scantily covered in reviews and other publications.

Surely, this is a great book, comprehensive, well-written and well-produced and all those concerned deserve to be congratulated. It is a must for those who have interest in the bio-synthetic aspects of metabolism.

J. V. B.

**Trace Elements in Human and Animal Nutrition,** Second Edition, completely revised. By E. J. Underwood. (Academic Press, New York and London), 1962. Pp. ix + 429. Price \$ 12.50.

The book under review was first published in 1956. During the last six years there has been considerable addition to our knowledge of the role of trace elements in human and animal nutrition. Among the wide array of new facts and ideas presented in this edition, particular mention may be made of the consideration of several elements which have attained added physiological status in recent years, namely, cadmium, chromium, rubidium and titanium, selenium as an essential element and its relationship to vitamin E, biochemical and physiological role of zinc and the relation of cobalt to vitamin B<sub>12</sub> synthesis in ruminants. References to important published research work given at the end of each chapter have added considerably to the value of the book. The author has succeeded to a remarkable degree in including a large amount of new material and bringing the book up-to-date. This book will serve as a volume of reference not only to advanced students of human and animal nutrition but also to research workers in the field of nutrition and biochemistry.

M. SWAMINATHAN.

**Advances in Clinical Chemistry—Vol. 4.** Edited by Harry Sobotka and C. P. Stewart. (Academic Press, London; India: Asia Publishing House, Bombay-1), 1961. Pp. xiv + 378. Price \$ 12.00.

The present volume, 4th in the series of 'Advances in Clinical Chemistry', has selected for presentation topics ranging from discussion of analytical methods to reviews on the biochemistry of diseases.

'Flame photometry' deals with the fundamental principles involved in this technique, details the operational procedures, and discusses its practical application particularly in the determination of sodium and potassium in biological fluids.

'The ultra micromethods' reviews the important apparatus necessary for the performance of ultramicrochemical analysis and covers the fields of titration, colorimetry, spectrophotometry, gasometry, pH determinations and electrophoresis.

'Organic acids in blood and urine' is a well documented report of the organic acids in the blood and urine of normal and pathological subjects. These include the acids of the tricarboxylic acid cycle, some aliphatic acids which are not members of the T.C.A. cycle and aromatic acids.

The syndromes resulting from or associated with different types of mellituria are just beginning to be appreciated. 'The non-glucose melliturias' summarises the metabolism of different sugars and presents the clinical conditions accompanying pentosuria, fructosuria, sucrosuria and malosurias.

'Ascorbic acid in man and animals' is a comprehensive review on the chemistry, biosynthesis, methods of analysis of ascorbic acid and on the role of ascorbic acid in nutrition of man and animals.

The current knowledge of the properties and physiological effects of the parathyroid hormone and biochemical disturbances of clinical hyperparathyroidism with special reference to calcium and phosphate in extracellular fluids is the main theme of an interesting review.

Specially commended is the presentation of 'Immune Electrophoresis-methods, interpretation and results'. Research workers in protein chemistry and immunology will welcome this clear, concise, practical guide to the new technique which appears to hold vast analytic potentialities applicable to clinical disorders and enzyme actions (enzymoelectrophoresis).

M. SIRSI.

#### Books Received

*Fluid Mechanics* (Vol. I). By M. Manohar. (Asia Publishing House, Bombay-1), 1963. Pp. xii + 418. Price Rs. 22-00.

*Structural Decisions*. By H. Werner Rosenthal. (Chapman and Hall, London W.C. 2), 1962. Pp. xxi + 417. Price 75 sh.

*Chemical Carcinogenesis*. By D. B. Clayson. (J. and A. Churchill Ltd., London W.1), 1962. Pp. viii + 467. Price 72 sh.

*Pulse Circuits*. By B. Chatterjee. (Asia Publishing House, Bombay-1), 1963. Pp. viii + 159. Price Rs. 10-00.

*Elementary Particles and Cosmic Rays*. By Alladi Ramakrishnan. (Pergamon Press, Headington Hill Hall, Oxford), 1962. Pp. xvi + 567. Price £ 5 net.

*Strange Particles and Strong Interactions*. By R. H. Dalitz. (Tata Institute of Fundamental Research, Bombay; Oxford University Press, Madras-2), 1962. Pp. 187. Price Rs. 19-00.

*Mineral Metabolism—An Advanced Treatise* (Vol. II, Part B). *The Elements*. Edited by C. L. Comar and F. Bronner. (Academic Press, New York), 1962. Pp. xvii + 623. Price \$ 20.00.

*Engineering Thermodynamics and Introduction*. By E. F. Pickerill. (Cleaver-Hume Press, Ltd., Kensington, London W. 8), 1963. Pp. xii + 308. Price 32 sh. 6 d.

*Nitrogen Metabolism in Plants*. By H. S. McKee. (Oxford University Press, Madras-2), 1962. Pp. 728. Price Rs. 84-00.

*University of Bombay Botanical Memoirs No. 4—The Asclepiadaceae and Periplocaceae of Bombay*. By Rev. H. Santapau and N. A. Irani. (The University of Bombay, University Bldgs., Fort, Bombay-1), 1960. Pp. 118. Price not given.

*British Medical Bulletin* (Vol. 19, No. 1, January 1963)—*Respiratory Physiology*. (The British Council, London W. 1), 1963. Pp. 96. Price £ 1.10 sh.

*Use of the Chemical Literature*. Edited by R. T. Bottle. (Butterworth and Co., Pub. Ltd., London,

*Botanical Monograph No. 3—Aquatic Angiosperms*. By K. Subramanyam. (Council of Scientific and Industrial Research, New Delhi-1), 1962. Pp. vi + 190. Price Rs. 20-00.

*Advances in Ecological Research* (Vol. 1). Edited by J. B. Cragg. (Academic Press, Inc. Ltd., London W.1), 1962. Pp. xi + 203. Price 45 sh.

*Physiology and Biochemistry of Algae*. Edited by R. A. Lewin. (Academic Press, Inc., New York-3, N.Y.), 1962. Pp. xxvii + 929. Price \$ 32.00.

*International Review of Experimental Pathology*. Edited by G. W. Richter and M. A. Epstein. (Academic Press, Inc., New York 3, N.Y.), 1962. Pp. x + 453. Price \$ 15.00.

*Elements of Tensor Calculus*. By A. Lichnerowicz. (Methuen and Co. Ltd., London W.C. 2), 1963. Pp. viii + 164. Price 21 sh.

*The Concept of the Positron—A Philosophical Analysis*. By N. R. Hanson. (Cambridge University Press, London N.W.1), 1963. Pp. ix + 235. Price 32 sh. 6 d.

## Award of Research Degree

The Bombay University has awarded the Ph.D. degree in Physics to Sri. B. N. Subba Rao of Tata Institute of Fundamental Research for his thesis entitled "Experimental studies of Some Medium Odd-A Nuclei".

The Maharaja Sayajirao University of Baroda has awarded Ph.D. degree in Biochemistry to Kumari Dharmishtha Kantilal Patwa for her thesis entitled "The Mechanism of Carotene Biosynthesis in Mangoes and Carrots".

## Indian Phytopathological Society

The Fifteenth Annual General Body Meeting of the Indian Phytopathological Society was held on 9th February 1963 in the Division of Mycology and Plant Pathology, I.A.R.I., New Delhi-12.

There was a business meeting in the morning at which Office-bearers for the year 1963 were elected. There was a symposium in the afternoon on "The Role of Therapeutic Treatments for Controlling Plant Diseases" in which several papers were discussed. Dr. D. J. Raski, Visiting Professor in Nematology from the University of California, gave an illustrated talk on "Control of Plant Pathogenic Nematodes". Dr. P. R. Mehta, President of the Society, delivered the presidential address on "Plant Pathology in India".

## The Institute of Physics and the Physical Society

(i) *Conference on Low and Medium Energy Nuclear Physics.*—The Institute of Physics and the Physical Society announces that it is arranging a Conference on "Low and Medium Energy Nuclear Physics" to be held at the University of Manchester from 4 to 6 September, 1963. The main topics to be covered will be: The production of beams of heavy ions; Heavy ion reactions; Properties of nuclear states, their measurement and comparison with theories of nuclear structure; Nuclear reactions at low and medium energies.

The foregoing topics will be reviewed in approximately nine invited papers. Offers of short contributions in these subjects for discussion should be sent before 21st June 1963 to the Conference Secretary, Dr. W. R. Phillips, The Physical Laboratories, The University, Man-

chester 13, accompanied by abstract 300 words.

(ii) *Solid-State Physics.*—The Institute of Physics and The Physical Society announce that it is arranging a Conference on Solid-State Physics at the H. H. Wills Physics Laboratory, University of Bristol, from 1-4 January 1964.

One of the main themes of this Conference will be the Fermi surface, and the invited speakers will include Professor A. I. A. Brown (University of Cambridge) and Prof. J. H. Cohen (Chicago). The Conference will provide an opportunity for workers in the field generally to meet and discuss recent developments. Accordingly, contributions on a wide topic of current interest in solid-state physics will be considered.

Offers of contributions should be sent to the Conference Secretary, Dr. R. G. W. Norrish, H. H. Wills Physics Laboratory, University of Bristol-8.

Further details of the above conferences will be available from the Administration of The Institute of Physics and The Physical Society, 47, Belgrave Square, London W.1.

## Science Progress

The latest issue (January 1963 No. 201) of this Quarterly Review contains the following articles: "Freshwater Fisheries Research in East-Africa" by the late Van Someren; "Environmental Geology and Sedimentary Geochemistry" by G. I. Plafieff; "Tectonics and Palaeogeography in the British Isles" by T. Neville George.

The section on Recent Advances includes "The Magnetic Field of the Sun" (Astronomy), "Micrometeorological Observations in Japan" (Meteorology), "General Principles of Organic Chemistry" (Organic Chemistry); "Ecology" (Botany) and "Whale Research" (Zoology).

## Twin and Forked Awning in Rice

Occurrence of double and triple awned rice spikelets has been recorded (vide Curr. Sci., 1936, 4, 739 and 1962, 35, 100). Shri P. Narahari of the Biology Division, Energy Establishment, Trombay, reports yet new variations in the awning of rice. During the main crop season of 1962, he observed panicle of rice in one of the pl-

tetraploid mutant of variety SR 26 B of Orissa, showed five unusual spikelets. One of them was sterile and lacked the middle nerve lemma. However, the two central nerves developed into a case of twin awning while the marginal nerves showed prominent endpoints. This suggests that each nerve of lemma or palea, under certain abnormal conditions, has the potentiality to develop into a separate awn. The other four spikelets, fertile and with short awns, showed forking at the tips. This forked nature of the awns, however, failed to occur in the subsequent generation showing that it is only a teratological variation with no genetic basis.

### Some Properties of Silver-Rich Tin-Silver Alloys

The mechanical properties of silver can be improved by alloying and for many applications, such as tableware and various items of jewellery, a silver alloy rather than pure silver is usually employed. Copper is a widely used alloying element and in sterling silver, for example, 92.5% is silver and the balance is usually copper. A disadvantage of the copper-containing alloys is their liability to develop green stains on prolonged contact with chlorides such as table salt or splashes of sea-water.

The Tin Research Institute has made a report of work carried out in its laboratories with the view to finding whether tin could with advantage replace copper as the hardening agent in silver within the solid solution range. The solid solubility of tin in silver at 700° C. is approximately 12% by weight, decreasing only slowly with decreasing temperature to approximately 10% at 300° C.

The work showed that copper in sterling silver could be replaced by tin to produce an alloy with improved resistance to some forms of corrosion while retaining comparable mechanical properties, including excellent ductility. The silver hardened with tin is not discoloured by contact with salt and is more resistant to atmospheres rich in sulphur dioxide than the copper containing alloys (Publication of Tin Research Institute, England).

### New Experiments on Large-scale Breeding of Micro-organisms

The demand for bacterial preparations, in the form of the micro-organisms themselves or the products of their vital activity, is steadily increasing. Microbiologists use them in many fields of science and technology, such as medicine, chemistry, soil biology, animal breeding and

agriculture. To meet this growing demand the microbes have to be bred in large quantities, several hundred kilograms at a time. This has posed the problem of evolving a dependable method of standard breeding of microbes without any hazard of breaks or accidents in the process.

It is being realised more and more that the classical nutrient medium for the micro-organisms, namely, meat broth, is becoming an impediment to their multiplication. Microbes develop well in meat broth, but sometimes, for reasons unknown, the whole batch perishes, or develops only partially. One method of standard breeding of microbes will be to make them grow and develop in a simple and well-known chemical nutritive medium. It has been noticed that micro-organisms develop most readily in casein solutions. In the U.S.S.R., the Gamaleya Institute and the Vologda Milk Institute and Regional Laboratory have jointly developed a special process of producing bacteriological casein.

Casein solutions, or meat and bone broth which micro-organisms can assimilate are not simply transformed into nutritive media. The complex molecules of broth proteins must be split into simple, easily assimilable compounds either by chemical means, or with active ferments which promote the quick disintegration of the protein molecules. For this purpose usually animal proteins are added to casein solutions. The new way of splitting broth proteins which has been found is by using fungus ferment instead of animal ferment. The fungus ferment is a preparation of mould fungus *Aspergillus terricola*, in the presence of which proteins are split into basic amino-acids. The fungus is not difficult to breed. Big colonies develop in two or three days on slightly moistened bran. They can be dried and kept in storage for an unlimited time, during which the ferment does not lose its quality.

The new method consists in effecting sharp changes in the temperature at which fungi are bred. It has been found that the activity of the ferment so prepared is raised about four times.—(Courtesy of U.S.S.R., Embassy in India, New Delhi.)

### Ceramic Photon Counters

The Geophysics Corporation of America, jointly with the NASA Goddard Space Flight Centre, have developed a new series of photon counters for inclusion in rocket and satellite space probes, or for use in laboratory research.

These counters may be described as small optical devices which measure the intensity and variability of ultra-violet radiation in narrow bands of the solar spectrum. External dimensions are: main body 1.000 in., mounting flange diameter 1.365 in., length 1.490 in., window aperture 0.375 in.

Aboard a rocket or satellite these ceramic counters can be used to measure Lyman-alpha radiation and other portions of the solar spectrum which do not penetrate to the earth's surface. In the laboratory, in conjunction with light sources able to simulate these wavelengths, the counters may be used to perform absorption studies of gases or to determine the reflectivity of metals. Measurements may be performed in such narrow spectrum bands as 1050-1180 Å, 1050-1250 Å, 1050-1350 Å, and 1225-1350 Å.

Counters are filled with a variety of gases and are equipped with a variety of crystal windows depending upon the experiment. Exhaust and filling tabulation is provided with either metal or glass pinch offs for mounting on a vacuum system. The instruments can be calibrated for absolute photon flux measurement, can be operated under gas amplification conditions, and may be used in combinations of two units to perform studies of other spectral regions.—(*J. Frank, Inst.*, 1962, 274, 532.)

#### Diamond Pressure Cell for High Pressure Optical Studies

A diamond pressure cell used along with a polarising microscope enables direct visual observations to be made of phase transitions and other changes occurring in transparent solids and liquids as a result of application of extremely high pressures. The device is being used by the National Bureau of Standards, U.S.A. for routine observations up to 70 kilobars (1 million lb./in.<sup>2</sup>), and observations up to 115 kilobars have also been made. So far alkali halides, and halides of thallium and silver, and a few other selected materials have been studied by this procedure.

The anvil-type diamond pressure cell consists of two carefully ground diamonds, each with a diameter of 1/16 in. For observing high pressure transformations at room temperature, the specimen is placed between the two diamond surfaces which are then squeezed together using a spring loading mechanism. This compresses the specimen into a film, and friction between the sample and the diamond surfaces prevents the specimen from completely extruding.

Some of the visual effects accompanying phase transitions are extremely vivid. Crystal growth

phenomena have been studied with the diamond squeezer and microscope. In potassium nitrate, for example, the crystals grown in the central high pressure region are much smaller and denser than those propagated in the peripheral, lower pressure regions of the cell. Further, it is observed that the crystals in the low pressure regions have a preferred orientation with their longest directions radial to the centre; this is also the direction of the pressure gradient. By changing pressure a growing crystal front that has the appearance of a liquid surface can be produced.

An absorption phenomenon that has been observed in thallium halides does not appear to be related to a phase change. At calculated pressures of 40 kilobars, thallium bromide changes from a near white to a lemon yellow colour when observed in monochromatic light. As pressure is increased, this colour changes to orange, then to a deep red, and finally, at about 90 kilobars, the material becomes opaque. On release of pressure the colour reverts back to the original white. The same behaviour is noted in thallium iodide and thallium chloride but at different pressures.

These changes are related to the changes in optical absorption and electrical resistance in the thallous halides at high pressures and are attributed to a decrease in the gap between the valence and conduction bands of allowed electronic energy.—(*Industrial Diamond Review*, 1963, 23, 42.)

#### Structure of Lysozyme

With the success achieved of the elucidation of the structures of myoglobin and haemoglobin (Kendrew *et al.* and Perutz *et al.*) by X-ray diffraction analysis, scientific interest is now being focussed on the study, by the same method, of the molecular structure of lysozyme. The enzyme lysozyme was discovered by Fleming in 1922. It is responsible for "the power of rapidly dissolving certain bacteria which is possessed by many animal and vegetable tissues and secretions, and to a very marked degree by egg-white". Recent studies have shown that the enzyme attacks a mucopolysaccharide component of bacterial cell-walls, liberating acetyl amino-sugars derived from glucosamine and muramic acid. The reaction appears to involve the breaking of a  $\beta$ -glycosidic linkage.

Chemical analysis of hen-egg-white lysozyme has shown that the molecule consists of a single polypeptide chain of about 129 amino-acid residues, cross-linked by four disulphide bridges. The amino-acid sequence is known in some



details but the position of the disulphide bridges have not yet been determined.

A detailed X-ray crystallographic investigation of the structure of hen-egg-white lysozyme is likely to lead to a knowledge of its molecular configuration which would be of special interest in connection with the mechanism of cell lysis and the structure of cell-walls.

Egg-white lysozyme can be crystallised in several crystal forms as the salts of mineral acids. Crystals of lysozyme chloride grown at pH 4.7 are tetragonal with cell dimensions  $a = b = 79.1$ ,  $c = 37.9$  Å, and space group  $P4_1 2_1 2$  or  $P4_3 2_1 2$ . Each unit cell contains eight lysozyme molecules (one per asymmetric unit), mol. wt. about 14,600, together with 1M sodium chloride solution which contributes about 33.5% of the weight of the crystal.

Three laboratories have sent preliminary reports of the results of their X-ray investigations on the structure of lysozyme (*Nature*, 1962, 196, 1173). The work at the Davy Faraday Research Laboratory of the Royal Institution, London, has been reported by D. C. Phillips

*et al.* The structure of tetragonal lysozyme chloride has been determined at 6 Å resolution by the method of isomorphous replacement, the heavy atom parameters used in the investigation being  $\text{PdCl}_4$ , MHTS (mercuri hydroxytoluene sulphonic acid) and mercuriodide. An X-ray crystallographic study of tetragonal lysozyme chloride crystals containing complex ions of niobium and tantalum has been reported by Prof. Corey *et al.* from the California Institute of Technology. A third preliminary report on lysozyme structure is by Dickerson *et al.* of the University of Illinois, in which they have calculated the three-dimensional structure of triclinic lysozyme nitrate to a resolution of 6 Å, using three isomorphous heavy atom derivatives:  $\text{HgI}_4 =$ ,  $\text{HgI Br}_4 =$  and  $\text{Pt Cl}_6 =$ .

The first electron density distribution in lysozyme in these investigations is suggestive of a polypeptide chain in a folded configuration. However, the analysis has to be carried further before this interpretation can be considered to be established.—(*Nature*, 1962, 196, 1173).

---

Particulars of *Current Science*—The Monthly Science News Journal of India—as per Form IV under Rule 8 of the Registration of Newspapers (Central) 1956.

- |  |  |
|--|--|
| 1. Place of Publication: Bangalore.  | 4. Publisher's Name, Nationality and Address:<br>Sri. S. R. S. Sastry, Indian, Manager,<br>Current Science Association, Bangalore-6. |
| 2. Periodicity of Publication: 26th of each month.   | 5. Editor's Name, Nationality and Address:<br>Dr. A. S. Ganesan, Indian, Editor, <i>Current Science</i> , Bangalore-6.               |
| 3. Printer's Name, Nationality and Address:<br>Sri. T. K. Balakrishnan, Indian, Superintendent, Bangalore Press, Bangalore-18. | 6. Name and Address of the Individual who owns the Paper: The Current Science Association, Bangalore-6.                              |

I, S. R. S. Sastry, hereby declare that the particulars given above are true to the best of my knowledge and belief.

Bangalore-6,  
March 20, 1963.

(Sd.) S. R. S. SASTRY,  
Publisher, *Current Science*.

---

185-63. Printed at The Bangalore Press, Bangalore City, by T. K. Balakrishnan, Superintendent, and Published by S. R. S. Sastry, for the Current Science Association, Bangalore.

All material intended for publication and books for review should be addressed to the Editor, *Current Science*, Raman Research Institute, Bangalore-6.

Business correspondence, remittances, subscriptions, advertisements, exchange journals, etc., should be addressed to the Manager, Current Science Association, Bangalore-6.

Subscription Rates : India : Rs. 12-00. Foreign : Rs. 16-00; £ 1-4-0; \$ 4.00.

640  $m\mu$  for the green leaf, and between 520  $m\mu$  and 650  $m\mu$  for the golden-yellow flower petal. It is evident that the slightly greater extension towards the red end observed in the spectrum of the flower petals cannot account for the enormous difference in colour between a golden yellow and a bright green. Indeed, the similarity of the two spectra is a most surprising and unexpected feature. Careful examination, however, reveals that the spectrum of the green leaf shows a low intensity in the spectral region between 560  $m\mu$  and 620  $m\mu$  as compared with the intensity in the same region of the yellow flower petals. It is clear from these observations that it is the absorption in the yellow and orange sectors of the spectrum and not the absorption in the red sector which is the operative factor resulting in the green colour of the leaves. The absorption by the two forms of chlorophyll in the wavelength range under reference, viz., between 560  $m\mu$  and 620  $m\mu$  is weak compared with the principal absorptions by them appearing in the red sector of the spectrum. But it is nevertheless the former and not the latter that results in our perceiving the characteristic green colour of the foliage of plants.

### 3. THE SPECTRUM OF THE "MORNING GLORY"

We shall next consider the remarkably interesting case of the flower known popularly as the "Morning Glory", the botanical name of the plant being "*Ipomea learii*". This plant is a creeper which when trained over a screen presents a magnificent sight in the early mornings with its green foliage studded over with large trumpet-shaped flowers of a deep blue colour. These show five divisions exhibiting the blue colour which are held together by narrow ribs of a purplish tint. The colour of the flowers is a highly saturated blue and may indeed be described as exhibiting spectral purity. It is distinctly more so when seen from the front by reflected light than as observed from the rear by transmitted light. That this difference is due to the extreme thinness of the petals is clear from the fact that when two of them are held together and the absorption path thereby doubled, the colour as seen by transmission is more highly saturated.

The spectrum of the "Morning Glory" may be observed either by the light reflected or by the light transmitted by the flower. In either case, the entire spectrum extending from the extreme violet to the extreme red may be seen without any noticeable change in the relative intensities of its different parts as compared

with the light reflected by a white sheet of paper, except in the wavelength range between 570  $m\mu$  and 630  $m\mu$ ; this spectral region is much diminished in brightness and a practically complete cut-off appears between 600  $m\mu$  and 630  $m\mu$ . To exhibit this feature, the spectrum of the transmitted light was photographed with a Hilger constant-deviation spectrograph on an Agfa panchromatic film. A tungsten filament lamp was used as the source of light in conjunction with a filter of copper sulphate solution so as to reproduce daylight conditions as nearly as practicable. Spectrograms obtained with three different exposures are reproduced together in Fig. 1 below, the first and the last in the series of five spectrograms being the comparison spectra exhibiting the light of the source employed. A dark band is very clearly seen in the three spectrograms not far from the red end of the spectrum, but clearly separated from it.

The "Morning Glory" thus presents us with the surprising fact that the weakening or removal from the spectrum of white light of a narrow strip covering its yellow and orange sectors transforms the resulting visual sensation from a pure white to a highly saturated blue closely resembling a pure spectral colour. As observed visually and as also shown by the spectrograms reproduced, the light which produces this sensation has its red, green, blue and violet sectors present in full strength and yet it does not excite in any observable degree the achromatic sensation which should, accordingly to the generally accepted beliefs, result from their superposition. These facts are highly significant in relation to our fundamental notions regarding physiological optics and the theory of colour perception.

### 4. THE SPECTRUM OF THE BLUE LOTUS

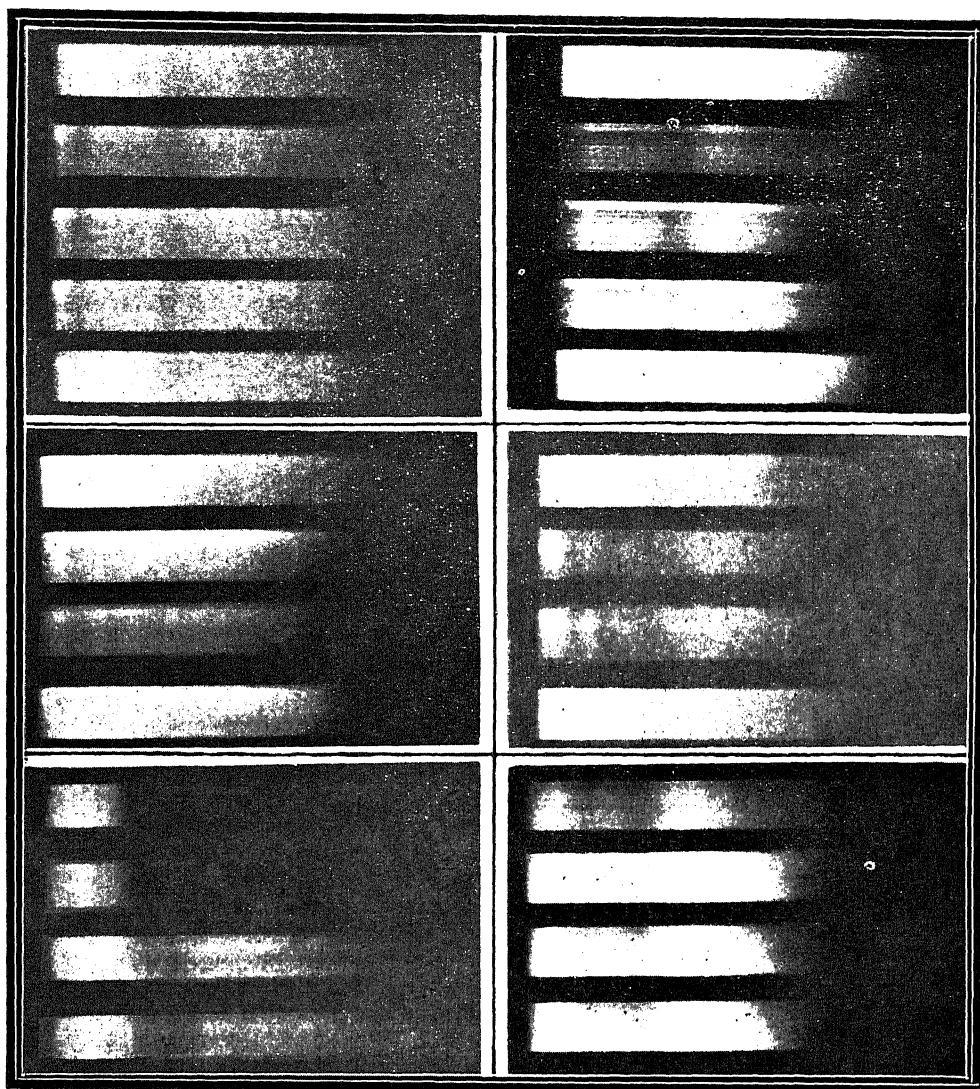
The lotus is one of the most famous and best-loved flowers of India. In the sunken garden attached to the author's residence at Bangalore, the floating leaves and blue flowers of a lotus make a most colourful exhibit in a large cistern of water. The petals of the lotus exhibit a purplish-blue colour which, though not so saturated as the blue of the "Morning Glory", nevertheless is very impressive by reason of the large number and geometric arrangement of the petals. The spectrum of the colour is readily observed either by reflection or by transmission. As in the case of the "Morning Glory", the violet, blue-green and red regions of the spectrum appear without any noticeable alteration of their relative

intensities; but the spectral region between 550  $m\mu$  and 610  $m\mu$  appears much weakened in its intensity, and two dark bands clearly separated from each other are noticeable in it. One of the bands appears between 550  $m\mu$  and 570  $m\mu$ , and the other between 590  $m\mu$  and

to the differences in the spectral composition of the light in the two cases.

#### 5. THE BLUE OF THE JACARANDA

Many flowering trees are known in India which in the appropriate seasons of the year



FIGS. 1-6. Spectra of Flower Petals by Transmitted Light.

Fig. 1. "Morning Glory" [with comparison spectra. Fig. 2. Jacaranda with comparison spectra. Fig. 3. "Heavenly Blue" (two petals) with comparison spectra. Fig. 4. Ground-Orchid with comparison spectra. Fig. 5. "Cloth of Gold" two petals and one petal. Fig. 6. Aster with purple petals.

610  $m\mu$ , the latter being the stronger and better defined absorption of the two. The differences in colour and the degree of its saturation in the case of the two flowers thus correspond

array themselves in flower-mantles of spectacular beauty. The Jacaranda of which the full botanical name is *Jacaranda mimosifolia* is singled out here by reason of the unique

character of its floral display. In the month of March each year, it bursts into flower and is then one of the most striking exhibitions of colour which could be imagined. The number of individual flowers on each tree is so enormous and they are so densely aggregated that each tree appears to carry a "blue mist" on its head. A whole avenue of such trees is an unforgettable sight.

The colour of the Jacaranda flowers is more nearly violet than blue. When freshly removed from the tree, they exhibit a vivid but not a saturated hue. But the colour becomes more vivid as the flower dries up. Its spectrum may be examined either by transmitted or by reflected light. Two absorption bands are noticeable, one between  $580\text{ m}\mu$  and  $600\text{ m}\mu$  covering the yellow region of the spectrum and another in the red beyond  $630\text{ m}\mu$ . The orange sector of the spectrum between  $600\text{ m}\mu$  and  $630\text{ m}\mu$  stands out as a bright strip between these two absorption bands. The third of the five spectrograms, reproduced in Fig. 2, shows this effect clearly, the first and the fifth in the group being the comparison spectra of the light source employed. Though the absorption in the yellow between  $580\text{ m}\mu$  and  $600\text{ m}\mu$  is not very conspicuous, it nevertheless plays the major role in determining the colourful appearance of the Jacaranda flowers, since the red end of the spectrum where the second absorption appears is intrinsically of low luminosity to our perceptions.

We may also refer here to two other plants which are well known and the spectral behaviour of whose flowers somewhat resemble those of the Jacaranda. One of them is the creeper known botanically as *Thunbergia grandiflora* which bears large five-lobed flowers popularly known as the "Heavenly Blue". The other is *Plumbago capensis* which is commonly planted out as hedges by reason of its bearing numerous clusters of small pale-blue flowers which make a fine show against the green foliage of the plant. Holding two of the lobes of the "Heavenly Blue" flower one behind the other, the transmitted light appears of a deeper blue than with one flower alone, and the absorption band in the yellow between  $580\text{ m}\mu$  and  $600\text{ m}\mu$  is then more conspicuous. A succession of fainter bands can also be seen in the region of smaller wave lengths. This effect is reproduced in Fig. 3. Very similar effects may also be observed with the *Plumbago capensis* flowers if they are bunched together, thereby increasing the absorption paths in the material.

## 6. FLOWERS EXHIBITING BAND SPECTRA

Of particular interest to the spectroscopist are those flowers which exhibit regularly-spaced band spectra in the light reflected by or transmitted through their petals. One such plant is a ground-orchid in the author's garden which bears elongated leaves like those of a palm and also carries long green stalks on which the flowers come out in succession, making a colourful show. The flowers have five petals of a reddish purple hue, and when viewed through a pocket spectroscope they exhibit a succession of bright and dark bands, as shown in the two spectrograms reproduced in Fig. 4 between the two comparison spectra of the light-source. The first dark band is very dark and sharp and appears at  $590\text{ m}\mu$ . The second dark band is somewhat broader but nearly as dark and appears at  $545\text{ m}\mu$ . The third dark band is rather diffuse and appears at about  $505\text{ m}\mu$ . The elimination of the yellow sector of the spectrum and the weakening of the green sector by the dark bands appearing in it are evidently responsible for the colour exhibited by the flower.

The flowers of the well-known garden shrub known as the *Cineraria* are also found to exhibit the band spectra in a conspicuous manner. Particularly striking in this respect are those varieties in which the petals exhibit a purplish-red hue. The band system in these cases resemble that observed with the ground-orchid described above and illustrated in Fig. 4. On the other hand, the varieties in which the petals are of a bluish-purple hue give a different type of spectra. The first bright band in the orange-red sector appears split into two, and the other bands also exhibit indications of such splitting. The blue flowers of the larkspur are also found to exhibit a set of rather closely-spaced bands in the red, orange and yellow sectors of the spectrum.

The question naturally arises why the absorption spectra exhibit a succession of dark and bright bands in the cases described. The suggestion may be ventured that we are perhaps concerned with a superposition of the vibrational and of the electronic absorption spectra of the molecules of the pigments present in the flowers.

## 7. THE SPECTRUM OF THE "CLOTH-OF-GOLD"

As has been remarked earlier, a great many flowers are known which exhibit a golden-yellow colour, and their spectra are usually very similar to each other. The faintest yellow

indicates the presence of a sensible absorption in the region of shorter wavelengths in the spectrum. The deeper the colour, the further has the absorption advanced from the violet into the blue and then towards the green. A change from yellow to orange indicates that the absorption has entered well into the green sector of the spectrum. The further the absorption advances into the green, the deeper becomes the orange hue. It then passes over into orange-red and finally into a scarlet colour.

The absorption by yellow flowers in the violet and blue sectors of the spectrum is usually so strong as to result in a complete cut-off of those regions. When the petals are very thin, however, it is possible with longer exposures photographically to record a feeble transmission in the blue and the violet sectors. It is interesting to remark that the transmis-

sion then appears as a succession of bands clearly resolved from each other.

The four spectrograms reproduced as Fig. 5 were recorded with the petals of a flower which is grown extensively in South India and finds a large market. It is known as "Kanakambaram" which may be translated into English as the "Cloth-of-Gold". The flower is of a beautiful orange-yellow tint. The individual petals are so thin that there is a sensible transmission over the entire spectrum which however exhibits a succession of bands, as can be seen in the third and fourth of the spectrograms reproduced as Fig. 5. When two petals are held together, however, the shorter wavelengths are cut off and only three bands are recorded, as can be seen in the first two spectrograms in Fig. 5. It would be interesting to ascertain the chemical constitution of the colouring matter which gives these remarkable effects.

## A METHOD OF DEGRADATION OF HARD RESIN FROM LAC

R. MADHAV, T. R. SESHADRI AND G. B. V. SUBRAMANIAN

Department of Chemistry, University of Delhi, Delhi-6

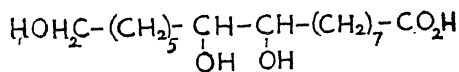
THE resin secreted by the insect *Laccifer lacca* Kerr has been the subject of extensive investigation over a number of decades. After the separation of the colouring matters and the waxes that accompany the resin it is generally divided into two parts on the basis of solubility: (1) ether-soluble soft resin and (2) ether-insoluble hard resin. The hard resin possesses the desirable resinous properties and consequently has been more widely investigated. It is apparent however that a rigorous separation of the soft and hard resin is often not made. This is the result of the following factors. The resin is a mixture of a number of polymeric acids with some free hydroxyl groups and its nature depends on storage and preliminary treatment. The remarkable property of the resin to form rubbery aggregates in contact with non-polar solvents, particularly ether, into which further penetration of the solvent becomes difficult, leaves the chemical separation often incomplete.

A fairly satisfactory and effective method of separation has now been attempted with a view to get a standard product. A concentrated alcoholic solution of the resin, free from wax and colouring matters obtained from *palas* (*Butea frondosa*) seedlac, was poured into

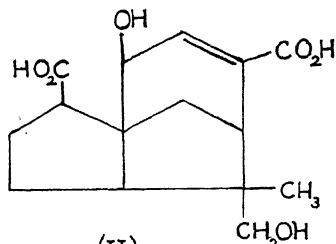
ether with continuous vigorous stirring. The precipitated hard resin was treated similarly two or three times until all the ether-soluble material was removed. The hard resin, obtained as an amorphous powder, gave consistent results and was employed in all the reactions. The viscous residue obtained by evaporating the ether solution consists of soft resin along with some hard resin that has been carried over because of the presence of some alcohol in the mother liquors.

There seems to be a need to explore the possibility of using new methods of study of lac resin. The hard resin has so far been investigated by alkaline degradation. Two fission products, aleuritic acid<sup>1</sup> (I) and shellolic acid<sup>2,3</sup> (II) have been isolated and completely characterised. Recently Cookson and his co-workers<sup>4</sup> reported the isolation of epishellolic acid in small yield. The isolation of an aldehydo acid named jalaric acid<sup>5</sup> was reported from the jalari (*Shorea talura*) seedlac. However the yields of aleuritic acid and shellolic acid have always been a subject of uncertainty. Yields of aleuritic acid that have been reported vary from 20% to 40%,<sup>6</sup> that of shellolic acid 0-8%.<sup>7</sup> Most of the remaining portion of the fission products has not been fully characterised,

The variations in the yields of aleuritic acid may partly be due to the indefinite quality of the resin employed and may partly be due to the lack of standardisation of the methods.



(I)



(II)

We have now conducted experiments on the hard resin leading to a clearer understanding of the quantities of the fatty acid part and terpenoids. Lac resin is believed to contain a variety of C—O—C links such as esters, lactones and lactides. In an attempt to break down all such links without allowing recombination, the resin was fissioned with constant boiling hydriodic acid and red phosphorus in acetic acid solution at 115° during 2 hours. The fissioned product could be separated into a fraction readily soluble in a solution of sodium hydrogen carbonate and an insoluble oily fraction. The soluble part gave an amorphous powder on acidification which answered the Liebermann-Burchard test. It appears to be a complex mixture of the terpenoids iodinated at the reactive centres. On treatment with zinc and hydrochloric acid, acetic acid mixture (1 : 1), it gave an iodine-free product (approx. 15% of the hard resin) answering the Liebermann-Burchard test. The sodium hydrogen carbonate insoluble oil on similar treatment gave a wax acid (approx. 30% of the hard resin). The rest of the fission product could not be isolated in any form.

The above wax acid was chromatographed on neutral alumina. Elution with petroleum (40–60°) followed by chloroform-ethanol and ethanol gave very minor amounts of waxes which were not investigated. Further elution with alcohol-acetic acid (9 : 1) mixture completely removed the acid, partly in combination with aluminium as a salt. The total solid (95% of the

weight chromatographed) was treated with dilute acid and it crystallised from light petroleum (40–60°) as plates, m.p. 61–62° C. I.R.,  $\nu_{\text{C=O}}$  = 1718  $\text{cm}^{-1}$ ;  $\nu_{\text{C=C}}$ , absent; U.V., low general absorption. (C, 75.3; H, 12.4%. Calc. for  $\text{C}_{16}\text{H}_{32}\text{O}_2$ : C, 75.0; H, 12.5%.)

Reverse phase chromatography with the system liquid paraffin/glacial acetic acid on Whatman paper No. 1, similar to the method described by Ballance and Crombie,<sup>8</sup> gave a single spot. It was identified as palmitic acid by a parallel run of authentic palmitic acid.

The method described above cleaves the resin smoothly into the components. However, the fatty acid portion of the resin could not exceed 40% in the present sample on the basis that all the  $\text{C}_{16}$  chain is present in the form of aleuritic acid. Further conclusion may be drawn that the hard resin does not contain any appreciable amounts of other chain lengths and no dicarboxylic acids or diols.

In order to fully understand the significance of this method of degrading the resin it may be mentioned that aleuritic acid itself under similar conditions has been studied and it is known to give quantitative yields of palmitic acid. For purposes of strict comparison with the behaviour of the resin, the reaction has now been carried out with the methyl ester of aleuritic acid and this also behaves in the same way. We could therefore conclude that all the aleuritic acid part of the resin could have come out as palmitic acid. However the same behaviour will be exhibited by more or less hydroxylated derivatives of aleuritic acid. With the exception of one claim of the isolation of a compound named Kerrolic acid,<sup>9</sup> reported to be a tetrahydroxy palmitic acid but not substantiated by any degradative evidence, no such compounds have so far been isolated and characterised. The aleuritic acid content of the resin could thus be reasonably estimated from the yield of palmitic acid obtained by this method and this should be about 35 to 40% in the present sample.

Alkaline hydrolysis of the same sample of hard resin was then investigated under a wide variety of conditions. The yield of aleuritic acid was invariably about 20%. It is not as yet clear why the yield is so low. However it may be mentioned that the terpenoid acids were not obtained crystalline. Considerable amount of uncrystallisable resin was left behind. Further study is necessary in order to get more detailed knowledge of the complexities.

Our grateful thanks are due to Dr. F. B. Padley of Unilever Research Laboratory, England and Dr. K. E. Murray of C.S.I.R.O., Australia, for authentic samples of palmitic acid and the Director, Indian Lac Research Institute, for a sample of palas seedlac.

1. Harries, C. C. and Nagel, W., *Ber.*, 1927, **60B**, 605.
2. Yates, P. and Field, G. F., *J. Am. Chem. Soc.*, 1960, **82**, 5764.

3. Carruthers, W., Cook, J. W., Glen, N. A. and Gunstone, F. D., *J. Chem. Soc.*, 1961, 5251.
4. Cookson, R. C., Lewin, N. and Morrison, A., *Tetrahedron*, 1962, **18**, 547.
5. Kamath, N. R., *Report of the Proceedings of the Symposium on Lac and Lac Products*, The Indian Lac Research Institute, Ranchi, 1956, p. 69.
6. Gidvani, B. S., *J. Chem. Soc.*, 1944, 306.
7. Harries, C. C. and Nagel, W., *Ber.*, 1922, **55B**, 3833.
8. Ballance, P. E. and Crombie, W. M., *Biochem. J.*, 1958, **69**, 632.
9. Weinberger, H. and Gardner, W. H., *Ind. Eng. Chem.*, 1938, **30**, 454.

## SOME STRUCTURAL FEATURES AND NEUROTOXIC ACTION OF A COMPOUND FROM LATHYRUS SATIVUS SEEDS

P. R. ADIGA, S. L. N. RAO AND P. S. SARMA

Department of Biochemistry, Indian Institute of Science, Bangalore-12, India

**'NEUROLATHYRISM'** a syndrome characterized by such profound neurological disturbances as weakness, irritability, spasticity and rigidity of leg muscles, paralysis and at times death, has been described in humans subsisting for prolonged periods on the seed-meal of certain legumes belonging to the genus of *Lathyrus*.<sup>1,2</sup> The existence of this crippling disease in an endemic form among the poor people in certain regions of Central India accustomed to consume *Lathyrus sativus* seeds (Kesari dal) as the major dietary constituent has been reported.<sup>3</sup> However, the exact chemical and biochemical characteristics of the neurolathrogen(s) present in the pulse have not been elucidated so far. The lack of a convenient experimental organism capable of responding to the neurotoxic principles present in the seed has been the chief obstacle which impeded any progress. In a recent communication from this laboratory,<sup>4</sup> we have detailed a procedure for the bulk isolation, from the aqueous ethanol-soluble fraction of the seed-meal of *L. sativus*, of a new ninhydrin-positive principle, present in the free form and toxic to several micro-organisms in minute amounts. Further, some of the physico-chemical properties of this compound and its degradation products have also been reported. This communication deals with our further findings on its structural aspects and profound neurotoxic action in experimental chicks.

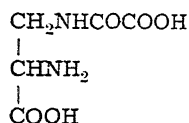
Earlier observations<sup>4</sup> that the toxic principle yielded, on acid and alkaline hydrolysis, another ninhydrin-positive compound, distinctly different

from the parent compound in its behaviour on paper chromatograms, ion-exchange column chromatograms (Dowex-50) and in electrophoretic mobility, has now been followed up by the bulk isolation of the degradation product by ethanol precipitation from acid hydrolysates of the parent compound and crystallization from methanol. On the basis of its elementary analysis, melting point, paper chromatographic and electrophoretic characteristics, and the properties of its dipicrate and diazotized derivatives, it has been identified as  $\alpha$ ,  $\beta$ -diamino propionic acid, a  $C_3$ -diamino monocarboxylic acid. It had a molar rotation  $[\alpha]_D^{22}$  of + 28.6 ( $c = 2, 6N HCl$ ) establishing thereby that it is of L-configuration. When tested with ninhydrin according to Rosen<sup>5</sup> the colour yield was 33% of that given by leucine on a molar basis, in agreement with the reported value in literature.<sup>6</sup> A comparison of the solid-phase infra-red spectra (KBr disc) of its monohydrochloride with that of an authentic sample of L- $\alpha$ ,  $\beta$ -diamino propionic acid monohydrochloride lends support to its identity with the proposed structure.

Absence of a positive reaction with Tollens reagent ruled out the possibility of an aldehyde type of group in the original toxic compound and its infra-red spectra did not show any characteristic peaks corresponding to either a —CN-function or a lactone ring. The elementary analysis indicated a difference of a  $C_2$ -fragment between the parent compound and the diamino propionic acid moiety and this  $C_2$ -fragment has since been isolated in a pure form from

the acid hydrolysates by repeated ether extraction and crystallization from ethanol. The latter fragment was identified as oxalic acid on the basis of its elementary analysis, melting point, the ability to decolorize acidic permanganate, behaviour on paper chromatograms and the colour reactions with indole<sup>7</sup> and diphenylamine<sup>8</sup> and the properties of its complex with ethanolamine.<sup>9</sup> Quantitative estimation of both the diamino propionic acid and oxalic acid in the acid hydrolysate of the original compound showed their presence in 1 : 1 molar ratio.

The coupling of the parent compound with fluorodinitrobenzene (FDNB) of Sanger,<sup>10</sup> yielded a DNP-derivative from which a free amino group could be liberated on hydrolysis with 6N HCl. Further reaction with FDNB yielded a di-DNP amino-acid with characteristics identical with those of di-DNP diamino propionic acid. This, together with the loss of colour reaction with ninhydrin on treatment with  $\text{Cu}(\text{NO}_3)_2$  reagent,<sup>11</sup> suggests the presence of only one free primary amino group in the original compound, the other being involved in the form of an acid-labile group possibly in the nature of  $-\text{CONH}$  function. In support of this is its solid state infra-red spectra showing strong peaks characteristic of such a group. That, it is the  $\alpha$ -amino group which is free, is indicated by ninhydrin colour reagent yield obtained with the original compound, which corresponds to 93% of that obtained with leucine on a molar basis, assuming the molecular weight of 175 for  $\text{C}_5\text{N}_2\text{H}_7\text{O}_5$ . On the basis of these observations, the following tentative structure for the toxic compound has been proposed.



$\beta$ -N-oxalyl,  $\alpha$ ,  $\beta$ -diamino propionic acid.

The total chemical synthesis to provide unequivocal proof for the proposed structure is currently in progress in this laboratory.

In view of the pronounced toxicity of this pure compound towards several micro-organisms,<sup>4</sup> its influence on the development of the larva of *Corcyra cephalonica* St. has also been investigated, since in earlier experiments<sup>4</sup> this organism has been shown to respond to the toxic principles of *L. sativus* seeds. It was found that the inclusion of the pure compound at 0.5% level in the basal wheat flour diet<sup>12</sup> inhibited the larval growth by over 60%.

In conformity with our earlier observations<sup>4</sup> that the toxic principles reside in the aqueous ethanol-soluble fraction of *L. sativus* seeds, is the recent observation of Roy *et al.*<sup>13</sup> who have demonstrated the development of neurological symptoms in chicks following injection of the concentrates of the aqueous ethanol-soluble fraction of *L. sativus* seeds. The pure toxic principle isolated from the pulse has, therefore, been examined for its neuro-lathrogenic action in chicks and was found to possess pronounced neurotoxic action.

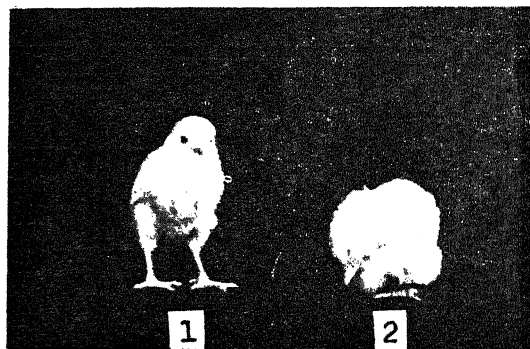


FIG. 1

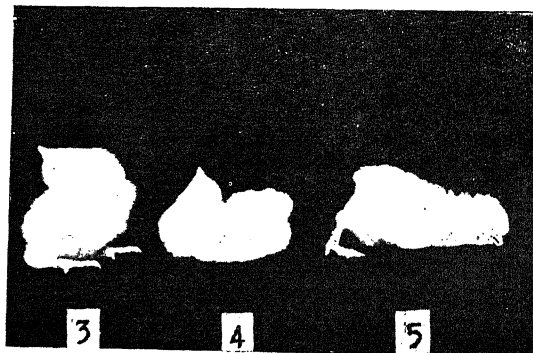


FIG. 2

FIGS. 1-2. No. 1. Control Chick. Nos. 2-5. Progressive symptoms in chicks administered toxic compound.

White Leghorn chicks, one day old and weighing 35-40 g./chick, obtained from the Central Poultry Farm, Hesserghatta, Bangalore, and maintained on the stock diet in electrically heated brooders were administered the toxic compound in aqueous solution (sodium salt, pH 6.8-7.0) at the level of 20 mg./chick. The chicks receiving the same amount of distilled water or the same molar concentration of L-glutamic acid in distilled water (pH 7.0) served as controls. Within 20-30 mins. after



a single intraperitoneal injection, all chicks (36 in number) developed typical and acute neurotoxic symptoms like inability to stand, head retraction, stiffening of the neck and extensor paralysis of the legs (Figs. 1, 2, Nos. 2-5). Administration through oral and subcutaneous routes required longer time (2-6 hours) to precipitate similar symptoms. At lower dosages (20-30 mg./chick) the birds recovered within 8-12 hours, while with larger dosages (30-60 mg./chick) or with continued daily dosage at lower levels the symptoms persisted even after 24 hours and became chronic in some and proved lethal to others. Injection of thiamine as hydrochloride (2 mg./chick) either before or after administration of the toxic principle neither prevented nor alleviated the toxic symptoms. It was also found that unlike the toxic substance intraperitoneal injection of either  $\alpha$ ,  $\beta$ -diaminopropionic acid or L-homo-arginine (recently isolated and characterized from *L. sativus*<sup>14</sup>) at comparable levels did not bring about any visible neural developments in experimental chicks. Detailed investigations are currently in progress in this laboratory to elucidate the biochemical and pharmacological basis of its neurotoxic action in this and other organisms.

The financial assistance of the Council of Scientific and Industrial Research, New Delhi, and The Rockefeller Foundation, New York, is gratefully acknowledged. Thanks are due to Dr. M. Sirsi for helpful discussions.

1. Selye, H., "Lathyrism," *Rev. Canad. Biol.*, 1957, **16**, 1.
2. Gardner, A. F., *Am. Jour. Clin. Nutr.*, 1959, **7**, 213.
3. Ganapathy, K. T. and Dwivedi, M. P., *Indian Council of Medical Research Publication*, Gandhi Memorial Hospital, Rewa, 1961.
4. Adiga, P. R., Padmaraban, G., Rao, S. L. N. and Sarma, P. S., *J. Sci. and Ind. Res.*, 1962, **21C**, 284.
5. Rosen, H., *Arch. Biochem. Biophys.*, 1957, **67**, 10.
6. Gallop, P. M., Seifter, S., Lukin, M. and Meilman, E., *Jour. Biol. Chem.*, 1960, **235**, 2619.
7. Bergerman, J. and Elliot, J. S., *Anal. Chem.*, 1955 **27**, 1014.
8. Huntress, E. H. and Mulliken, S. P., *Identification of Pure Organic Compounds*, John Wiley & Sons New York, 1941, p. 99.
9. Keiser, B., *Ind. Eng. Chem. (Anal. Ed.)*, 1940 **12**, 284.
10. Sanger, F., *Biochem. Jour.*, 1945, **39**, 307.
11. Larson, P. O. and Kjaer, A., *Biochim. Biophys. Acta*, 1960, **38**, 148.
12. Sivarama Sastry, K., Radhakrishna Murthy, R. and Sarma, P. S., *Biochem. Jour.*, 1958, **69**, 425.
13. Roy, D. N., Nagarajan, V. and Gopalan, C., *Curr. Sci.*, 1963, **32**, 116.
14. Rao, S. L. N., Ramachandran, L. K. and Adiga, P. R., *Biochemistry*, 1963, **2**, 298.

## TRAINING PROGRAMME IN PHYSIOLOGY OF REPRODUCTION

M. R. N. PRASAD

Department of Zoology, University of Delhi, Delhi-6

THE Department of Zoology, University of Delhi, organised in collaboration with Dr. S. J. Segal, Ford Foundation Consultant in Reproductive Biology, a series of seminars on Physiology of Reproduction as part of the training programme envisaged in the Ford Foundation grant to the Department. The programme was organised in order to enable scientists with varied background to acquire a competent appreciation of the advances in the different fields of reproductive biology. The series began on the 22nd October 1962 and was concluded on the 11th March 1963. The participants in the programme were drawn from the different medical colleges in Delhi, Directorate-General of Health Services, Directorate of Family Planning, Vallabhbhai Patel Chest Institute and the staff and students of the different departments of the Delhi University. A training programme

of this magnitude and coverage was the first of its kind to be organised in India. The speakers in the series were drawn from the U.S.A., Israel, United Kingdom, Australia, Switzerland besides those from the All-India Institute of Medical Sciences and the Departments of Chemistry and Zoology of the Delhi University.

The series was inaugurated by Dr. C. D. Deshmukh, Vice-Chancellor, Delhi University, on the 22nd October 1962. Inaugurating the series, Dr. Deshmukh traced the development of the family planning programme in India as a Government-sponsored enterprise and stressed the need for research and training in effectively combating population growth. The series began with a seminar by Dr. B. R. Seshachar who discussed the cytological variants of the sex-determining mechanism in animals and concluded with a description of recent methods of

recognition of the structural and numerical variations in chromosomes and their importance in the diagnosis of sexual abnormalities. While sex is determined at the time of fertilisation, a favourable hormonal environment is necessary for the differentiation of the sex glands and the development of the duct system. Dr. M. R. N. Prasad gave experimental evidence in support of the view that the foetal testis secretes a morphogenetic substance which is masculinising while in its absence, the female type of development ensues. Dr. S. J. Segal traced the gradual evolution of the four types of reproductive patterns in mammals, namely seasonal breeders, estrus breeders, progestational breeders and menstrual breeders. The functions of the pituitary, which regulates the cyclical activity of the gonads, are controlled by higher brain centres located in the hypothalamus by a delicately regulated feed-back mechanism. Dr. M. T. Clegg showed that electrical lesions in different regions of the hypothalamus, pituitary transplantation to extra-hypothalamic sites, cannulation of the cavernous sinus and assay of the blood for gonadotrophins are the different experimental approaches for the elucidation of hypothalamo-hypophyseal interrelationships. Recent evidence points to the existence of different trophic hormone-releasing factors in the hypothalamus. Dr. B. K. Anand extended this observation and developed the hypothesis that the control of reproduction is perhaps not regionally localised in the hypothalamus alone but is more generalised to the lymbic system as a whole. Changes in the pituitary gland correlated with immaturity, maturity and other physiological states and the demonstration of the cell types in the pituitary gland by a variety of tinctorial reactions were discussed by Dr. B. I. Sundararaj.

The varying pattern of the biosynthesis of steroid hormones from acetate or cholesterol as precursors depends on the presence of different hydroxylases. Dr. G. P. Talwar pointed out that the exact mechanism of action of hormones at the cellular level was still not clearly understood but it was possible that the hormones may act in different ways, namely, by altering the permeability of the cell membrane or by stimulation of enzyme activity or by activation (or removal of repression) of the genetic apparatus. He reviewed his own work on the action of growth hormone and concluded that growth hormone might act by specifically activating release of messenger RNA which carries the genetic information from the nucleus to the

cytoplasm where it initiates synthesis of specific proteins. Dr. M. R. N. Prasad and Dr. Anna Southam described the structure and function of the testis and the ovary from the prenatal stages to senility. Dr. Sabita Sujan discussed the components of the seminal plasma and the biochemical pathways for their utilisation by the spermatozoa. Two colour films, one showing various phases of reproduction in the rat and the phenomenon of ovulation and egg transport in the rat made by Prof. R. J. Blandau, University of Seattle, and another showing different aspects of fertilisation in the sea urchin and the limpet made by Prof. Albert Taylor, California Institute of Technology, were shown through the courtesy of the producers.

The delicate hormonal interplay controlling ovum implantation is a species specific phenomenon. Dr. M. R. N. Prasad reviewed the present status of the problem and pointed out the significance of using prevention of implantation as a method of fertility control. Dr. Sabita Sujan discussed the fluctuating levels of different hormones of placental and gonadal origin and their physiological significance in the maintenance of pregnancy. Dr. C. W. Lloyd, Director of the Worcester Foundation Training Programme in Physiology of Reproduction, participated in the discussions. The initiation and maintenance of lactation is an integrated climax to an orderly sequence of events occurring during pregnancy and culminating in parturition. Dr. M. R. N. Prasad discussed the factors regulating lactation and the relation between the nervous system and the milk-ejection reflex. Dr. V. V. S. Murthy reviewed the advances in the field of synthesis of protein hormones and discussed the biological and pharmacological action of a number of synthetic analogues of oxytocin and vasopressin which could be of use in clinical practice.

Immunological approach to fertility control has recently attracted considerable attention. Dr. N. R. Moudgal initiated the discussion on immunoreproduction by reviewing his work on immunochemistry of ovine and human interstitial cell stimulating hormone and pointed out that immunological methods could be used for testing the purity of hormones. A number of scientists who attended the VII International Congress of the International Planned Parenthood Federation in Singapore in February 1963 were present at the seminar and participated in the discussion which was moderated by Dr. S. J. Segal. Dr. Seymour Katsh, University of Colorado, showed that testicular extracts

elicited specific antibody responses which, when injected to normal males, resulted in destruction of all cell types in the seminiferous epithelium except the spermatogonia. The antibody response is possibly associated with the mucoprotein-complex of the acrosome which is antigenic. Dr. R. G. Edwards, University of Glasgow, reviewed his own work on the antigenicity of mammalian spermatozoa and its relation to induced infertility. It was pointed out that the application of the results of studies in immuno-reproduction for control of fertility has to await further experimentation. Prof. M. C. Shelesnyak, Weizmann Institute of Science, Israel, reviewed his classical work on the role of histamine in the induction of the decidual cell response as a prelude to implantation of the ovum. Histamine release is associated with a "surge" of estrogen from the ovary on the morning of day 3 of normal pregnancy in the rat. Dr. I. G. White, University of Sydney, reviewed the present status of biochemistry of Semen and discussed the pathways of utilisation of Glyceryl-Phosphoryl-Choline by spermatozoa.

A series of three special seminars was given by visiting scientists. Dr. M. J. Wells, University of Cambridge, described in *Octopus* the occurrence of a brain-optic gland-gonad axis similar to the hypothalamo-pituitary-gonad axis in higher vertebrates. Dr. Ernst Knobil, University of Pittsburgh, reviewed his work on placental transfer of TSH in monkeys. He described the elegant methods developed by him for the cannulation of foetal arteries and veins to characterise and measure the blood levels of transferred substances and their degradation products. Dr. H. P. Klinger, University of Basel, Switzerland, gave an account of the chromosomal abnormalities in sex. The

application of the sex chromatin test and study of chromosomal patterns has led to a clear understanding of the role played by genes on the X-chromosomes in causing colour blindness and mongolism. Such abnormalities occur specially in children born of older mothers. In this context Dr. Klinger was particularly interested in the follow-up of children born of mothers who were exposed to the long-term action of ovulation-inhibiting oral contraceptives.

The concluding seminar in the series on Control of Fertility was given by Dr. S. J. Segal. Dr. C. D. Deshmukh presided. Dr. Segal reviewed the various methods of fertility control and pointed out that the use of one or more methods depended on the social, religious and economic conditions of the population. An ideal contraceptive satisfying the following criteria, namely, (a) absence of local action on coitus, (b) occasional treatment, (c) little medical attention, (d) easy availability and cheapness, and (e) freedom from side effects, remains to be developed. The extent to which oral contraceptives which have been successfully tried in the U.S.A., and other countries will be useful in India depends on considerations of cost and complexity of usage. Trials are being made with intra-uterine coils and rings.

Dr. Deshmukh, congratulating the participants and speakers on the successful completion of the Training Course, envisaged a bright future for the programme. He hoped that a more comprehensive programme including laboratory exercises would be given during 1963-64. He desired that the Department of Zoology, in collaboration with different organisations in Delhi, should develop the programme as a centre for training in Physiology of Reproduction for India on the lines of the Worcester Foundation Training Programme in U.S.A.

## LINEAR POLARIZATION OF THE RADIO WAVES FROM SATURN

After the discovery by Sloanaker of the intense 10-cm. radiation from Jupiter, measurements at 960 Mc./s. by Radhakrishnan and Roberts, using a variable-spacing phase-switched interferometer technique, established that the planetary emission was strongly polarized. These observations have led to further researches on planets as polarized radio sources.

In a recent communication (*Phys. Rev. Letters*, February 1963), Sloanaker *et al.*, reporting their observations on the decimeter (3,200 Mc./s.) radio emission from Saturn, find that it is strongly linearly polarized, the degree

of polarization being about 20%. The data were taken with a solid-state maser amplifier mounted at the focus of a 84-ft. radio-telescope.

In the case of Jupiter, the decimeter radiation has been interpreted as due to relativistic electrons spiraling in a magnetic field whose axis of symmetry is tilted by about  $10^\circ$  with respect to the rotational axis. If a similar model is assumed in the case of Saturn, the observations would require relativistic electrons radiating predominantly in the region of high latitudes.—(*Phys. Rev. Letters*, February 1963.)

## LETTERS TO THE EDITOR

VOLATILIZATION OF BORON IN THE  
DIRECT CURRENT ARC

THE importance of boron as a trace element in plant physiology has been well established. The present study of its vapourization behaviour was taken up with a view to developing a suitable spectrographic method for its determination in plants and soils and because of lack of volatilization data on boron. The investigation was carried out with the so-called moving plate technique employing the carbon as well as the copper direct current arc. 500 p.p.m. of boron as  $B_2O_3$  was added to a synthetic plant base consisting of 'Specpure' chemicals with percentage composition  $CaCO_3$  77.4;  $K_2CO_3$  6.5;  $MgSO_4$  6.3;  $KH_2PO_4$  3.8;  $SiO_2$  2.7;  $MgO$  1.2;  $Fe_2O_3$  1.1;  $Na_2CO_3$  0.9. The mixture was filled into a carbon electrode (anode) diameter 4.5 mm., depth 2 mm. and thickness 1 mm. The trace of boron contained in the carbon rod (JM 1B) did not materially affect the results. A current of 10 amp. at 230 volts was passed to produce an arc 3 mm. long, the height of the spectrograph slit being kept at 3 mm. The plate holder was racked every 15 sec. till the entire sample was consumed. From the microphotometric measurements of the B 2498 line a semiquantitative estimate was made of the percentage of boron vapourized in each interval and the volatilization curve A in Fig. 1 was drawn.

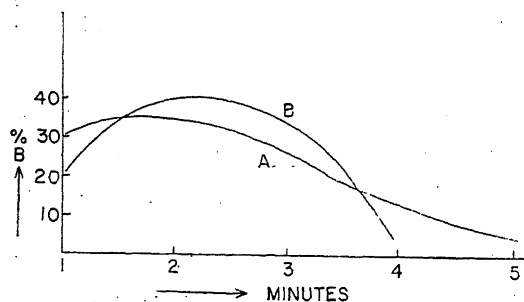


FIG. 1

Vanselow and Liebig,<sup>1</sup> and Vanselow and Bradford<sup>2</sup> who worked with graphite electrodes using anode excitation and a similar base classified boron as a highly volatile element and placed it in the category of zinc and cadmium. The present finding does not support

this view as seen from curve A, which shows that boron continues to emit till the complete consumption of the sample. In a recent personal communication Vanselow<sup>3</sup> has expressed agreement with the above views. The curve B (Fig. 1) was obtained from Vanselow's volatilization data for boron. The broad similarity of trends in the two curves is evident.

Ahrens and Taylor<sup>4</sup> who worked with mixtures of oxides grouped boron with the involatile elements. Zaidel, Prokofiev and Raiski<sup>5</sup> have placed boron in the volatile group. These authors, however, seem to be uncertain about the actual vapourization behaviour of boron.

The vapourization of boron was similarly studied with the copper arc, the sample being placed in the cathode. The volatilization rate was found to fall steadily and not abruptly with passage of time as in the case of the carbon arc, and boron remained unvolatilized even after six minutes, by which time the sample was consumed. A similar study was also made with a soil base consisting of 63%  $SiO_2$ . In this case also boron did not volatilize completely before the consumption of the sample. This is in agreement with the finding of Rodriguez<sup>7</sup> that in soils boron persisted unvolatilized in the copper arc even after six minutes. These findings are contrary to Mitchell's<sup>6</sup> assertion that in the copper arc, in a silicate base, one minute is sufficient to volatilize all boron in the sample.

The most probable explanation for the uncertain behaviour of boron in the arc is that it exists in the arc in the form of volatile oxides as well as other unvolatile compounds such as borates. Besides, reactions occurring in the electrodes resulting in the reduction of oxide to boron and formation of boron carbide and boron nitride, both very stable compounds, cannot be ruled out. The actual manner in which boron is introduced into the arc is not yet properly understood.

The authors wish to thank Dr. H. D. Chapman, Visiting Professor on the Rockefeller Foundation at this Institute, for helpful advice and discussion. They are also thankful to Dr. A. P. Vanselow of the Citrus Research Centre, University of California, for kindly providing a

copy of his mimeograph on spectrochemical analysis and data on the volatilization of boron.  
Division of Agricultural Physics, Y. V. KATHAVATE.  
Indian Agric. Res. Institute, G. D. RIHANI.\*  
New Delhi-12, October 19, 1962.

\* Present address: Defence Research Laboratory, Delhi.

1. Vanselow, A. P. and Liebig, G. F., Jr. *Spectrochemical Methods Mimeograph*, College of Agriculture, University of California.
2. — and Bradford, G. R., *Soil Sci.*, 1957, **83**, 75.
3. —, Personal Communication.
4. Ahrens, L. H. and Taylor, S. R., *Spectrochemical Analysis*, 2nd edition, Addison Wesley Publishing Co., Inc., New York, 1961.
5. Zaidel, A. N., Prokofiev, V. K. and Raiski, S. M., *Tables of Spectral Lines*, YEB Verlag Technik, Berlin, 1955.
6. Mitchell, R. L., "Technical Comm. No. 44." *Commonwealth Bur. Soil Sci.*, Harpenden, England.
7. Rodriguez, A., *Anales edafol. Y., Fisiol. Vegetal.*, 1954, **13**, 893.

### LIFETIME STUDIES IN TELLURIUM-121

l-FORBIDDEN M1 transitions are known to be retarded by factors of 30 to 900<sup>1</sup> compared to single particle estimates. The internal conversion coefficient for the 214 kev-transition in  $\text{Te}^{121}$  leads to M1 assignment. The ground state of  $\text{Te}^{121}$  is known to be  $\frac{1}{2}^+$ . In this region there are available s  $\frac{1}{2}$  and d  $\frac{3}{2}$  single particle orbitals. The M1 assignment for the 214 kev-transition is consistent with the assumption that these configurations describe the ground state and first excited state respectively, with the condition, however, that the transition should be l-forbidden ( $\Delta l = 2$ ) and consequently slower than the single particle speeds.

By means of delayed-coincidence measurements we have set an upper limit of 1 nanosecond on the lifetime of the 214 kev-level. A  $\text{Te}^{121m}$  source (half-life = 154 days) was produced by (p, n) reaction on natural Sb. Delayed-coincidences were measured between the K X-ray following the internal conversion of the 82 kev-transition and the succeeding 214 kev-gamma ray. For the prompt coincidence curve the coincidences between K X-ray and 160 kev. gamma-ray following the decay of 104 day  $\text{Te}^{123m}$  (which was simultaneously produced along with  $\text{Te}^{121m}$ ) were made use of. The 160 kev-level is known to have a half-life of  $1.9 \times 10^{-10}$  seconds. Figure 1 shows the results of delayed-coincidence measurements. We arrive at an upper limit of 1 nanosecond for the 214 kev-level in  $\text{Te}^{121}$ .

This lifetime upper limit yields an upper limit of 400 for the M1 reatrdation factor, which is not small enough to rule out the

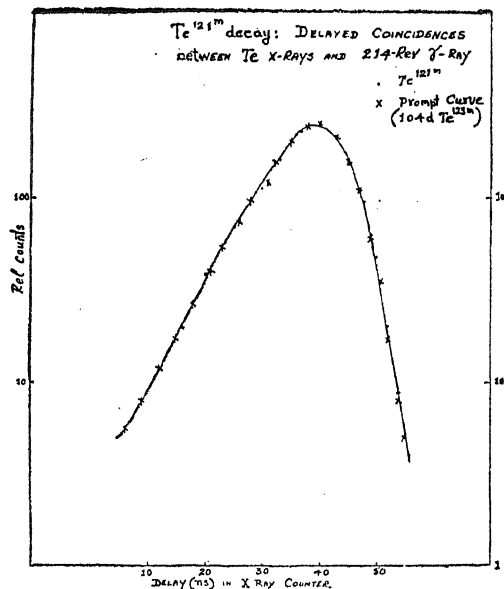


FIG. 1

l-forbidden assignment. The author wishes to thank Prof. P. S. Jastram for his hospitality at Ohio State University.

Department of Physics, M. K. RAMASWAMY.  
Karnatak University,  
Dharwar-3, November 28, 1962.

1. Ramaswamy, M. K., *Nuovo Cim.*, 1962, submitted.

### SYNTHESIS OF 1, 1-DIPHENYL 4-SUBSTITUTED THIOSEMICARBAZIDES

In the course of investigation on thiosemicarbazides, a number of 1, 1-Diphenyl-4-substituted thiosemicarbazides were synthesised. In the present communication, various 1, 1-diphenyl-4-alkyl/aryl/aralkyl substituted thiosemicarbazides are described.

Unsymmetrical diphenyl hydrazine required for the purpose was prepared according to literature.<sup>1</sup> This was condensed with various Isothiocyanates<sup>2</sup> in benzene solution to obtain the title compounds. The compounds are described in Table I. All these are colourless compounds crystallised from alcohol.

#### EXPERIMENTAL

All melting points are uncorrected. The following method is typical,

TABLE I

No.	R =	M.P.° C.	Mol. formula	Analysis	
				% S. Calc.	% S. found
1	C <sub>6</sub> H <sub>5</sub>	..	C <sub>19</sub> H <sub>17</sub> N <sub>3</sub> S	10.0	10.0
2	<i>o</i> -CH <sub>3</sub> C <sub>6</sub> H <sub>4</sub>	..	C <sub>20</sub> H <sub>19</sub> N <sub>3</sub> S	9.6	9.5
3	<i>p</i> -CH <sub>3</sub> C <sub>6</sub> H <sub>4</sub>	..	C <sub>20</sub> H <sub>19</sub> N <sub>3</sub> S	9.6	9.4
4	<i>p</i> -CH <sub>3</sub> O-C <sub>6</sub> H <sub>4</sub>	..	C <sub>20</sub> H <sub>20</sub> N <sub>3</sub> OS	9.1	8.9
5	<i>p</i> -CH <sub>3</sub> O-C <sub>6</sub> H <sub>4</sub>	..	C <sub>20</sub> H <sub>20</sub> N <sub>3</sub> OS	9.1	9.0
6	<i>p</i> -BrC <sub>6</sub> H <sub>4</sub>	..	C <sub>19</sub> H <sub>16</sub> BrN <sub>3</sub> S	8.0	7.8
7	<i>p</i> -IC <sub>6</sub> H <sub>4</sub>	..	C <sub>19</sub> H <sub>16</sub> IN <sub>3</sub> S	7.2	7.0
8	<i>n</i> butyl	..	C <sub>17</sub> H <sub>21</sub> N <sub>3</sub> S	10.7	10.7
9	C <sub>6</sub> H <sub>5</sub> CH <sub>2</sub>	..	C <sub>20</sub> H <sub>19</sub> N <sub>3</sub> S	9.6	9.6
10	<i>o</i> -C <sub>10</sub> H <sub>7</sub>	..	C <sub>23</sub> H <sub>19</sub> N <sub>3</sub> S	8.7	8.6
11	(C <sub>6</sub> H <sub>5</sub> ) <sub>3</sub> C	..	C <sub>32</sub> H <sub>27</sub> N <sub>3</sub> S	6.6	6.3

1, 1-Diphenyl-4-phenyl thiosemicarbazide : (i.e., 1, 1, 4-Triphenyl thiosemicarbazide).—A solution of unsym. diphenyl hydrazine (2.02 gm., 0.011 mole), phenyl isothiocyanate (1.35 gm., 0.01 mole) in benzene (15 ml.) was refluxed on a water-bath for three hours. After cooling and distilling off the benzene the solid obtained was triturated with 5% hydrochloric acid and finally washed with water. Yield 2 gm. (62%). It was crystallised from ethanol twice to obtain an analytically pure sample. M.P. 178° C.

Department of Chemistry, K. K. GINWALA.  
St. Xavier's College, J. P. TRIVEDI.  
Ahmedabad-9, November 14, 1962.

1. Mann, F. G. and Saunders, B. C., *Practical Organic Chemistry* (Longmans), 1961, p. 202.
2. Trivedi, J. P. et al., *Curr. Sci.*, 1961, 30, 415.

### SNOW CRYSTALS FORMED IN CIRRUS CLOUDS

WEICKMANN<sup>1</sup> has shown that ice crystals formed in cirrocumulus, cirrus castellatus and cirrus uncinus clouds (135–165% humidity w.r.t. ice) have the form of hollow hexagonal prisms. The relation between this form and the snow star form is discussed in this note. The formation of the various forms of snow crystals has been fully considered by Mason and Ludlam.<sup>2</sup>

Conditions of crystallisation have been classified by Saratovkin.<sup>3</sup> He places snow crystal formation in class GII and considers the process as crystallisation from water vapour dissolved in air. GII growth commonly gives rise to dendritic forms. Saratovkin considers two types of dendritic crystal forms, conventional tree form dendrites and skeletal dendrites. The tree form dendrites are well illustrated by the snow star crystals which form in nimbostratus, stratus

and stratocumulus clouds (100–115% humidity w.r.t. ice). These snow star dendrites usually have 3-fold, 6-fold or 12-fold<sup>4</sup> external symmetry and form at temperatures of between –15 and 0° C. The prisms form in cirrus clouds at –50 to –30° C. and have 6-fold symmetry and should be skeletal dendrites.

Certain substances are known to have two dendritic forms. Saratovkin illustrates this with crystals of potassium iodide. Observed skeletal crystals are often metallic and the edge development at the expense of the faces yields hopper growths, e.g., bismuth and occasionally austenite.<sup>5</sup> Hexagonal hopper growths are not frequently observed; in fact uniaxial hopper growths are uncommon. Lemmlein<sup>6</sup> shows a tetragonal hopper in which the hopper formation is restricted to the square faces. It is postulated that in uniaxial crystals the skeletal dendrite form may exhibit the typical hopper growth on certain faces only. As in the case of Lemmlein's tetragonal crystal it appears that in snow crystals the hopper growth is restricted to the planes which define the uniaxial symmetry. Thus the ice dendrites forming in cirrus clouds have the form of hollow hexagonal prisms.

The form of cirrus crystals is fairly constant. These are formed in high cloud systems and the fall conditions which cause different pattern growths in star crystals are absent. Fall induces vibrations in the system and Tolansky growth conditions prevail.<sup>7</sup>

Northampton College,  
London EC 1, England,  
February 5, 1963.

I. J. SMALLEY.

1. Weickmann, H., *Die Eisphase in der Atmosphäre Rep. and Trans. No. 716* (Volkenrode), Ministry of Supply (A), 1947.
2. Mason, B. J. and Ludlam, F. H., "Microphysics of Clouds," *Repts. Prog. Physics*, 1951, 14, 147.

3. Saratovkin, D. D., *Dendritic Crystallisation*, Consultants Bureau, N.Y., 1959 (English Trans. from Russian).
4. Bentley, W. A. and Humphreys, W. J., *Snow Crystals*, McGraw-Hill, N.Y., 1931 (Currently reprinting by Dover).
5. Howé, H. M., *The Metallography of Steel and Cast Iron*, McGraw-Hill, N.Y., 1916.
6. Lemmlein, G. G., *Sector Structures in Crystals*, Akademizdat, Moscow, Leningrad, 1948 (in Russian).
7. Tolansky, S., *Discovery*, 1960, 21 (12), 524.

### MAGNETISM AND MOLECULAR STRUCTURE: STUDY OF MONOSUBSTITUTED PHENOLS AND THEIR ETHERS

In the previous investigation<sup>1</sup> magnetic susceptibilities of monosubstituted benzoic acids were reported. In this paper the investigation has been extended to the study of monosubstituted phenols and their ethers. The method followed was the same as the one described in the earlier paper, and the error of measurement of specific magnetic susceptibility ( $\chi$ ) was in no case greater than  $\pm 0.001$ . The results are given in Table I in which  $\chi$  and  $\chi_m$  respectively represent the specific and molar susceptibilities of the compounds. All the values are expressed in  $-1 \times 10^{-6}$  c.g.s. units.

On the consideration of the orienting influence of the substituent group present in the benzene nucleus and on the basis of Langevin's theory of diamagnetism French<sup>2</sup> suggested that in disubstituted benzene derivatives containing two electron repelling groups, the susceptibility of the three isomerides should be in the order  $o > p > m$  whereas in compounds containing meta-orienting substituents the susceptibility of the meta compound should be higher than either the ortho or para isomeride. The observed values of susceptibilities given in the table indicate that they do not show any systematic trend as one passes from one series to another.

A careful examination of the results shows that in some compounds containing purely ortho-para orienting groups, the susceptibility of the para isomer is higher than that of the ortho compound. The smaller magnitude of the ortho compound may be attributed to the size of the substituents present in these isomerides. It is probable that the large substituents may be restricting the orbital motions of the electrons thus reducing the value of  $\sum r^{-2}$  and hence a consequent lowering in the diamagnetic value of the compound.

In conclusion it may be stated that besides electronegativity of the substituents, the electron density at various positions in the benzene

TABLE I  
Magnetic susceptibilities of phenols and their ethers

Compound	Phenol		Methyl ether		Ethyl ether	
	$\chi$	$\chi_m$	$\chi$	$\chi_m$	$\chi$	$\chi_m$
Catechol	..	0.620 68.20	0.638 79.11	..	..	..
Resorcinol	..	0.610 67.10	0.625 77.50	..	..	..
Hydroquinone	..	0.608 66.88	..	..	..	..
<i>o</i> -Amino Phenol	..	0.624 68.01	0.654 80.44	0.675 92.47	..	..
<i>m</i> -Amino Phenol	..	0.620 67.48	0.650 79.95	0.670 91.90	..	..
<i>p</i> -Amino Phenol	..	0.628 68.45	0.655 80.56	0.682 93.43	..	..
<i>o</i> -Nitro Phenol	..	0.406 68.94	0.549 84.14	0.594 99.24	..	..
<i>m</i> -Nitro Phenol	..	0.475 66.02	0.532 81.39	..	..	..
<i>p</i> -Nitro Phenol	..	0.459 63.80	0.518 79.25	0.566 94.55	..	..
<i>o</i> -Cresol	..	0.674 72.79	0.700 85.40	0.718 97.64	..	..
<i>m</i> -Cresol	..	0.667 72.03	0.695 84.79	0.715 97.24	..	..
<i>p</i> -Cresol	..	0.672 72.57	0.697 85.03	0.717 97.51	..	..
<i>o</i> -Bromo Phenol	..	0.469 81.13	0.489 91.44	0.507 101.99	..	..
<i>m</i> -Bromo Phenol	..	0.459 79.40	..	..	..	..
<i>p</i> -Bromo Phenol	..	0.480 83.02	0.505 94.43	0.524 105.32	..	..
<i>o</i> -Chromo Phenol	..	0.603 77.18	0.622 88.68	0.639 100.01	..	..
<i>m</i> -Chromo Phenol	..	0.604 77.59	0.623 88.79	0.641 100.39	..	..
<i>p</i> -Chromo Phenol	..	0.605 77.75	0.625 89.10	0.644 100.80	..	..
<i>o</i> -Hydroxy Benzoic acid	..	0.551 76.03	0.586 89.07	..	..	..
<i>m</i> -Hydroxy Benzoic acid	..	0.540 74.52	0.575 87.55	0.605 100.55	..	..
<i>p</i> -Hydroxy Benzoic acid	..	0.533 73.53	0.569 86.53	0.600 99.63	..	..
Salicylaldehyde acid	..	0.528 64.40	0.559 79.00	0.581 87.20	..	..
<i>m</i> -Hydroxy Benzaldehyde	..	0.535 65.27	0.563 76.57	0.587 88.01	..	..
<i>p</i> -Hydroxy Benzaldehyde	..	0.548 66.80	0.574 78.00	0.598 89.70	..	..

ring is also affected by steric effect and such other factors.

Chemistry Department, D. S. KENKARE.  
Institute of Science, Bombay, M. G. DATAR.  
Bombay-1, October 6, 1962.

1. Datar, M. G., *Curr. Sc.*, 1962, **31**, 15.
2. French, *Trans. Faraday Soc.*, 1945, **41**, 676.

### CATALASE ACTIVITY AND IRON DEFICIENCY IN SOYBEAN LEAF TISSUE

IRON is an essential nutrient element for plants and its importance in chlorophyll formation has long been known. The iron itself does not enter into the composition of the chlorophyll molecule. However, iron in leaves is found to occur in combination with some proteinous fractions, presumably enzymes, which activate formation of certain other proteins intimately related to chlorophyll.

All known enzymatic systems depending on iron involve porphyrin molecules. Porphyrins by themselves show no catalytic activity. It is only when the porphyrins form co-ordination compounds with iron that they appear to develop properties of great physiological significance.

Catalase is a conjugated protein containing an iron porphyrin as its prosthetic group. Reduction in the iron supply would naturally impress upon the catalase activity. An experiment was therefore conducted to examine if the measurement of catalase activity would indicate iron deficiency in leaf tissue.

Two sets of soybean plants were raised in solution culture under identical conditions (in a plant growth chamber). However, one set of plants received only 0.25 p.p.m. iron supply in the culture medium. When the plants were three weeks old, replicated leaf samples were collected from both the sets of plants. The catalase activity was determined manometrically by allowing the catalase preparations to react with hydrogen peroxide and measuring the oxygen liberated at every two minutes interval for a period of twenty minutes. The results obtained are given in Table I.

It was suspected that chlorophyll and other organic compounds in the leaf tissue reacted with hydrogen peroxide liberating oxygen. In order to test this, one of the enzyme preparations from normal leaf sample was heated to 80° C. in a water-bath for five minutes and tested for its catalase activity. It was found that the heated preparation lost the activity

almost completely demonstrating the presence of catalase in the other preparations tested.

TABLE I

*Catalase activity\* in soybean leaves from plants grown in nutrient solution with or without adequate iron*

Replications	Normal	Low iron	Normal but heated
<i>μl. Oxygen/mg. dry wt./20 minutes</i>			
1	9.17	6.52	0.22
2	7.78	6.68	..
3	11.44	6.82	..
4	8.69	6.26	..
5	9.11	7.28	..
6	9.90	7.00	..
Mean	9.34	6.76	..

\* Oxygen liberated in presence of enzyme preparation from hydrogen peroxide.

The set of plants that received very low supply of iron apparently did not exhibit symptoms of iron deficiency (chlorosis) on their leaves. However, the low iron supply had influence on the catalase activity of the leaf tissue. The enzyme activity was reduced by an extent of 32% as a result of iron deficiency. The results of the investigation therefore lead to the conclusion that the measurement of catalase activity served as an indicator of the physiological response of the plants to their nutrient status of iron.

Agronomy Department,  
Utah State University,  
Logan, Utah, U.S.A.,  
September 20, 1962.

N. G. PERUR.  
R. L. SMITH.  
HERMAN H. WIEBE.

### CHEMICAL EXAMINATION OF CANARIUM BENGALENSE ROXB.

*Canarium bengalense* Roxb. (Family: Burseraceae) is reputed for its fragrant oleoresin obtained as an exudation from wounds or fissures in the bark which is burnt as an incense. Although chemical examination of some other species of *Canarium* has been reported<sup>1-3</sup> work on this species was yet to be undertaken.

1850 gm. of powdered air-dried bark was exhaustively extracted in a Soxhlet with petroleum ether (b.p. 60-80°). The oil obtained (16.3 gm.) was hydrolysed with 10% alcoholic potassium hydroxide and the non-saponifiable neutral fraction amounting to 0.74 gm. was chromatographed over Brockmann alumina. In the benzene eluent a colourless crystalline material separated (yield, 0.03%) which



crystallised from alcohol as plates, m.p. 136-137°;  $[\alpha]_D - 34^\circ$  (chloroform). It gave bluish pink coloration with Liebermann-Burchard reagent and a positive Salkowski reaction. The acetate prepared with pyridine and acetic anhydride melted at 131°;  $[\alpha]_D - 37^\circ$  (chloroform). The benzoate prepared with pyridine and benzoyl chloride melted at 142°;  $[\alpha]_D - 13^\circ$ . The physical data of all these compounds resembled fairly with those of  $\beta$ -sitosterol and its corresponding derivatives and a mixed melting-point of the acetate with an authentic sample of  $\beta$ -sitosterol acetate remained undepressed. The bark of *C. bengalense* was thus found to contain  $\beta$ -sitosterol as its non-saponifiable component.

Chemical Division, P. C. MAITI.  
Botanical Survey of India, R. M. BERT.  
Calcutta, October 20, 1962.

1. Bhuvanendram, R., Manson, W. and Spring, F. S., *J.C.S.*, 1950, p. 3472.
2. Vasistha, R. C. and Muthana, M. S., *J. Sci. Ind. Res.*, 1955, p. 632.
3. Dutt, S., *Ind. O. and S. J.*, 1960, 26, 123.

## STUDIES ON BOMBAY RATS

### (Frequency of Rat Population)

THE Indian Plague Commission<sup>8</sup> mentioned that a predominant majority of rats found in Bombay were *R. rattus*. Sokhey and Chitre<sup>11</sup> reported that *B. bengalensis* was coming in increasing numbers in the collection of rats in Bombay. It is well established by various reports at the Haffkine Institute that *R. rattus* was now very resistant to Plague and that *B. bengalensis* was susceptible. Deoras and Gokhale<sup>4</sup> reported that *B. bengalensis* was predominating in the rat collections and Deoras<sup>5</sup> mentioned of the decreasing susceptibility of *B. bengalensis* to Plague. This trend in the increase in numbers of *B. bengalensis* and its susceptibility is an important development from the Plague epidemiological point of view.

The percentages of rat numbers mentioned above were calculated from the random rat catch the Municipality was doing in Bombay. This was done by the wonder traps and other mechanical means. These wonder traps have a small opening which does not allow a fair size *B. bengalensis* to enter and secondly in spite of the continuous control measures by various means including cynogassing undertaken by the Bombay Corporation this increase in the numbers of *B. bengalensis* seems to have been maintained.

*B. bengalensis* is a susceptible rat, it does more damage by burrowing and in spite of control measures, it is still found to be on the increase. Studies were therefore needed to be done to see the actual percentage of this rat in the total definite collection by other methods than wonder traps, and these studies were designated as frequency of rat population. Stress was laid on the percentages of *R. rattus* and *B. bengalensis*.

There are a number of techniques to study the frequency of rat population,<sup>1,3,6,7,9,10,12,13</sup> of these a modified capture-recapture release technique of Hayne<sup>6</sup> was adopted. A modified trap was used which permits only one rat at a time. The studies were therefore done with this trap which is adopted to catch bigger rats also, and the results compared with the catch by the older means to see if the picture available is a true indication of the percentage of different rats in the total population of rats in Bombay.

About one hundred of these new traps were kept in 900 sq. feet area, thirty feet apart in a field at Bhandup 20 miles from Bombay. The traps were baited each evening and the rats collected next morning, were numbered, marked by toe-clipping and released two miles away. The temperature, percentage humidity, flowering plants, ectoparasites and predators were noted. The data of rat collection in this 900 sq. feet area for one year were converted for the acre and it came to be 29185 rats per acre. Table I gives the percentage of different rats collected in this area. This table also gives similar percentages by this new trap and technique at Kamatipura and Butcher island done for various periods. The table indicates the frequency of *R. rattus* and *B. bengalensis* rat populations (percentages) in a given area at the places. It also shows that in the heart of the town at Kamatipura the field rat predominates, while in the field, though the field rat is more in numbers than *R. rattus*, there is another rat *L. nagarum* which predominates. *L. nagarum* and *G. gujarati* are new records for that locality.

The collections done by the Municipality by wonder traps at Kamatipura, Mahim, Bhandup, Ghatkoper, hut area near the fields at Bhandup and the Port Trust area has been recorded in Table II. In this table it is seen that in the crowded locality of Bombay, *B. bengalensis* predominates while in the suburbs and Port Trust area, *R. rattus* is collected more in numbers.

TABLE I  
Percentage of rat collection (Frequency of Rat Population)

Sl. No.	Locality	Total rats caught	Period of collection	No. of traps used	Percentage of collection		Remarks
					Rr	Bb	
1	Bhandup (field)	1010	12 months	100	17.0	20.0	NEW TRAPS. Here the rats are continuously trapped in a small measured area, marked, released and recaptured.
2	Kamatipura (residences)	330	1 month	70	37.27	50.6	
3	Butcher island (open area)	31	3 weeks	100	91.7	2.7	

Rr—*Rattus rattus*; Bb—*Bandicota bengalensis*.

TABLE II  
Percentage of rat collection as per Municipal data

Sl. No.	Locality	Total rats caught	Period of collection	No. of traps used	Percentage of collection		Remarks
					Rr	Bb	
1	Kamatipura	4552	122 days	70	21.5	45.4	WONDER TRAPS. All in the residential areas. Here a number of rats are trapped in an unspecified area by a number of wonder traps.
2	Mahim	7372	do.	120	28.3	43.2	
3	Bhandup (huts)	94	28 days	50	91.5	5.3	
4	Bhandup and Ghatkoper	2394	122 days	25	88.3	3.9	
5	Port Trust	1368	do.	unspecified	54.9	28.2	

Rr—*Rattus rattus*; Bb—*Bandicota bengalensis*.

TABLE III  
Collection of different rat species

Sl. No.	Locality	Total rats caught	Period of collection	Percentage of rat species in the collection		Remarks
1	Whole of Bombay	433380	12 months	Bb	41.3	By wonder traps and other means near residences
		..	..	Rr	27.2	
		..	..	Rn	15.1	
		..	..	Bi	0.2	
		..	..	Mm	2.7	
		..	..	Sc	9.5	By wonder traps
2	Huts near the fields at Bhandup	94	4 weeks	Rr	91.5	
		..	..	Bb	5.3	
3	Bhandup field	1010	12 months	Bi	3.2	By new traps in the field
		..	..	Ln	56.0	
		..	..	Bb	20.0	
		..	..	Rr	17.0	
		..	..	Bg	4.0	
		..	..	Bi	1.0	
		..	..	Gg	1.5	

Bb—*Bandicota bengalensis*, Bi—*Bandicota indica*, Bg—*Bandicota gigantea*, Gg—*Golunda gujarati*, Ln—*Leopoldia nagarum*, Mm—*Mus musculus*, Rr—*Rattus norvegicus*, Rr—*Rattus rattus*, Sc—*Sturnus ceruleus*.

Table III compares the percentages of different rats collected by the wonder trap for the whole of Bombay for 12 months with the percentage of collection in the field at Bhandup for a similar period by the new technique. This table indicates, that while on an overall basis *B. bengalensis* predominates in the town, and though *B. bengalensis* is a major rat in the

field also, it is dominated by *L. nagarum* which is a very small rat that is also very susceptible to plague.

The studies have discussed the reasons for this change in the percentage domination by the two rats, *R. rattus* and *B. bengalensis*, in the rat population of Bombay since 1912 in the various localities, and the utility of the new

technique for similar studies in Plague endemic areas. The details of the results are being published elsewhere.

I am thankful to Messrs. Chaturvedi, Vad, Janakiraman and Shah for help in these investigations, to Mr. Ganapat Patil of Bhandup and Port Trust authorities for the facilities and to I.C.M.R., I.C.A.R. and the Director, Haffkine Institute, for assistance.

Haffkine Institute,  
Parel, Bombay-12,  
December 8, 1962.

P. J. DEORAS.

1. Beer, J. R., Lukens, P. and Olson, D., *Ecology*, 1954, **35**, 437.
2. Calhoun, J. B., *J. Mamm.*, 1952, **33**, 139.
3. Davis, D. E. and Zippin, C., *The Jour. Wildlife Management*, 1954, **18** (2), 170.
4. Deoras, P. J. and Gokhale, M. S., *Jour. Bom. Nat. Hist. Soc.*, 1958, **55** (3), 450.
5. Deoras, P. J., *Curr. Sci.*, 1960, **29**, 475.
6. Hayne, D. W., *J. Mamm.*, 1949, **30**, 399.
7. Harrison, J. I., *Malayan Nature Journal*, 1957, **12**, 82.
8. Indian Plague Research Commission, *J. Hyg. Camb.*, 1912, **1**, 229.
9. Manville, R. H., *J. Mamm.*, 1949, **30**, 27.
10. Murry, K. F., *Ibid.*, 1957, **38**, 441.
11. Sokhey, S. S. and Chitre, G. D., *Haffkine Institute Annual Report*, 1937, (2), p. 38.
12. Southern, H. N. and Laurie, E. M. O., *J. Ani. Ecol.*, 1946, **15**, 134.
13. Zippin, C., *Biometrics*, 1956, **12**, 163.

#### A NOTE ON THE ANNUAL REPRODUCTIVE CYCLE OF THE PRAWN *PENAEUS INDICUS* (M.-EDW.) OF MADRAS COAST

THERE exists several methods for determining the annual reproductive cycles of marine invertebrates such as observations on spawning, occurrence of larvæ, frequency of occurrence of mature individuals, appearance of ripe gametes in gonads and the brooding of eggs. That the gonad index is a function of the breeding cycle of marine invertebrates was first established by Bennet and Giese (1955).<sup>1</sup> The gonad index, i.e., the ratio of the gonad size to the body weight, "is considered to be a measure of the average state of the reproductive population" (Giese, 1959).<sup>2</sup> Graphical representation of the annual reproductive cycle is possible when the gonad index is plotted against time. This gonad index referred to as 'ponderal index' or 'condition factor' is widely used in determining the breeding cycles of fishes. But this method has been applied to several echinoderms and molluscs off Pacific Coast of United States by Giese and his co-workers as reviewed by him

(Giese, 1959). Tropical Crustacea received less attention and the available information on their breeding cycles is scanty. Indian Penæid prawns have been studied only recently and Menon (1953, 1955)<sup>3,4</sup> assessed the breeding seasons of *Parapenæopsis stylifera* and *Metapenæus dobsoni* using the occurrence of mature prawns and larvæ, during several months, as the two factors. The present author has also determined the breeding season of *Metapenæus affinis* (unpublished)<sup>5</sup> by adopting the same method. There is no record of any study on a crustacean using gonad index as a factor for determining the annual reproductive cycle either in temperate or tropical waters and the present investigation appears to be the first attempt. The variations of the gonad index in *Penæus indicus* and the seasonal changes of various biochemical constituents have been studied for a period of one year and only the fluctuations of the gonad index are presented here.

Samples of 30-70 specimens of the prawn were collected at random from the commercial landings at Santhome, Madras. The time and the method of sampling in a month was maintained uniform. The males and the females were separated and length measurements were taken. Then the animals were dried by towelling with filter-papers and the weight of each prawn was recorded. The gonads were removed and weighed immediately in a physical balance nearest to a milligram and were then dried in a desiccator under reduced pressure over sulphuric acid for further chemical analyses. The wet weight of the gonad divided by the wet weight of the body and multiplied by 100 gave the gonad index. The mean value of the indices for males and females were calculated for every month. Besides, cyclical changes of biochemical constituents such as water content, total nitrogen, proteins, non-proteins, glycogen, lipids and ash content in the gonads following the reproductive cycle were studied.

The results are presented in Fig. 1. It can be seen that the gonad index is always less than 1 in males even in the months when breeding activity appears to be pronounced. The factor varied from 0.33 (November, 1961) to 0.79 (July, 1962) during the year under study. It is of interest that there is a consistency in the gonad index during the major part of the year. On the other hand the gonad index of females ranged from 0.38 (November, 1961) to 4.54 (August, 1961). The variations are marked and high gonad index is noticed only during

4 months of the annual cycle (Fig. 1). When the mean gonad index of males and females together is plotted it can be seen that it follows the pattern of females. The peaks are found in the months of August and September 1961 and of May and July 1962. There are indications of a minor peak in March, 1962. This is true both in females and the combined gonad index.

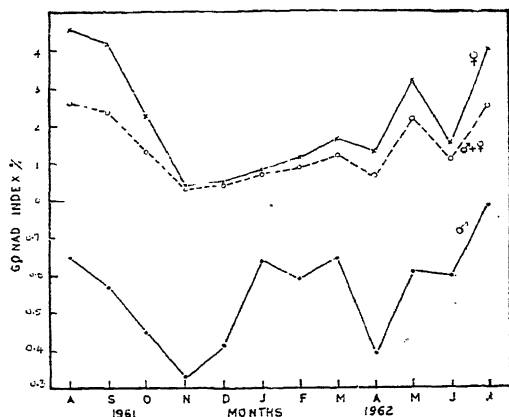


FIG. 1. The annual reproductive cycle as indicated by the gonad index in the prawn *Peneus indicus* during the years 1961-62.

From the above study it is possible to deduce that the breeding activity of the species as indicated by the gonad index appears to be pronounced in the months of May, July, August and September of an year and also that there may be lesser activity in March. The occurrence of planktonic larvae of the species shows correlation with the periods of high gonad index. The biochemical changes which have been followed substantiate the above inference. Panikkar and Aiyar (1939)<sup>6</sup> are of the opinion that this species is a continuous breeder and Panikkar and Menon (1955)<sup>7</sup> suggest that there are indications of two periods of breeding, namely, October to November and May to June. But the findings of the present author appear to be tenable as regards the annual reproductive cycle of *Peneus indicus*. The results of the biochemical investigations will be published elsewhere.

The author expresses his deep gratitude to Dr. S. Krishnaswamy, Reader, for suggesting the problem and guidance, and to Dr. C. P. Gnanamuthu, Director, for encouragement.

University Zoological C. B. SUBRAHMANYAM.  
Research Laboratory,  
Chepauk, Madras-5,  
October 23, 1962,

1. Bennet, J. and Giese, A. C., *Biol. Bull.*, 1955, **109**, 226.
2. Giese, A. C., *Ann. Rev. Physiol.*, 1959, **21**, 547.
3. Menon, M. K. J. *Zool. Soc. India*, 1953, **5** (1), 153.
4. —, *Indian J. Fish.*, 1955, **2** (1), 41.
5. Subrahmanyam, C. B. (Unpublished).
6. Panikkar, N. K. and Aiyar, R. G., *Proc. Ind. Acad. Sci.*, 1939, **9 B**, 343.
7. Panikkar, N. K. and Menon, M. K., *Proc. Indo-Pacific Fish. Comm.*, 1955, **Sec. 3**, 347.

## A QUALITATIVE STUDY OF AMINO-ACIDS IN THE CHICK ORGANIZER REGION

WADDINGTON<sup>1</sup> showed that the anterior one-third of the primitive streak is the primary organizer in the chick embryo just as the dorsal lip of the blastopore is the organizer in the amphibia. It was also demonstrated by him that a diffusion of the inductive principle takes place from the organizer graft into the reacting ectoderm (Waddington<sup>2</sup>). We have therefore studied the amino-acid content of the anterior one-third of the primitive streak by paper chromatographic analysis.

Fresh fertilized hens' eggs were incubated for about 18 hours to get primitive-streak stage embryos. The embryos were separated from the vitelline membrane in Compton saline. The anterior one-third of each primitive streak was excised, washed carefully to remove all adhering yolk, rinsed quickly in distilled water and suspended in acetone (Durrum *et al.*<sup>3</sup>). After about 100 pieces were thus collected (dry weight 2.75 mg.) the acetone was evaporated and the residue was hydrolysed by 6N hydrochloric acid and 90% formic acid mixture (1:1) (Durrum *et al.*<sup>3</sup>) *in vacuo* for 24 hours at 110° C. The hydrolysates were dried, washed repeatedly in water and again dried in vacuum and then dissolved in 10% isopropyl alcohol. The amino-acids were separated by spotting the sample on Whatman No. 1 filter-paper. The papers were run in butanol : acetic acid : water and phenol : ammonia : water systems unidimensionally (Alexander and Block).<sup>4</sup> Ninhydrin in acetone (0.25%) was used as developer (Toennies and Kolb).<sup>5</sup>

From the ninhydrin positive spots observed in the chromatograms of both systems we could detect phenylalanine, threonine, glycine, serine and glutamic acid. In the aqueous phenol-ammonia system in addition to these we could detect aspartic acid. In the butanol : acetic acid : water system we could detect arginine, leucine, proline, histidine and methionine in

addition to the five common amino-acids already mentioned. In the aqueous phenol-ammonia system one ninhydrin positive spot could not be identified. In the butanol: acetic acid: water system between aspartic acid and glutamic acid we found two unidentifiable ninhydrin positive spots. Lakshmi<sup>6</sup> observed the presence of glutathione and methionine in her experimental work using platonic iodide which is a specific developer for sulphur containing amino-acids.

Thus twelve amino-acids were identified and three could not be identified.

The authors wish to thank the University Grants Commission (M. S. L.) and the Government of India (G. V. S.) for the research fellowships awarded to them and Prof. Leela Mulherkar for the facilities for work provided.

Department of Zoology, M. S. LAKSHMI.  
University of Poona, GAJANAN V. SHERBET.  
Poona-7, October 29, 1962.

1. Waddington, C. H., *Phil. Trans. Roy. Soc.*, 1932, 221, 179.
2. —, *Nature*, 1933, 131, 275.
3. Durrum, E. L., Block, R. J. and Zweig, G., *Paper Chromatography and Paper Electrophoresis*, Academic Press, Inc., New York, 1958.
4. Alexander, P. and Block, R. J., *Laboratory Manual of Analytical Methods of Protein Chemistry*, Pergamon Press, 1960.
5. Toennies, G. and Kolb, J. J., *Anal. Chem.*, 1951, 23, 823.
6. Lakshmi, M. S., In preparation for the press, 1962.

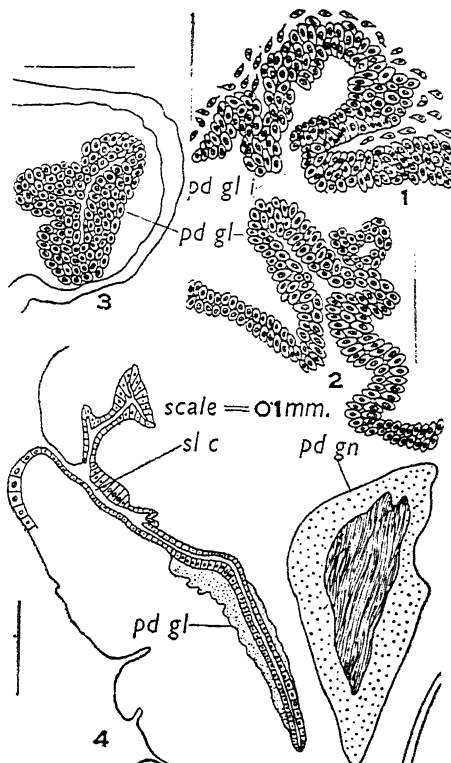
### MORPHOGENESIS OF THE PEDAL GLAND IN THE GIANT LAND SNAIL *ACHATINA FULICA BOWDICH*

The pedal gland is an unpaired structure present in all gastropods, mostly being restricted in the propodium, possibly except *Vermetus* (Salensky, 1887), where a posterior pedal gland has been recorded.

The rudiments of the pedal glands are paired and first appear by invaginations in a 2.5 mm. embryo, 7 days old (Fig. 1). The two rudiments unite later at the middle and form the single gland in the adult.

The several layer thick ectoderm forming the sole of the foot becomes invaginated on either side of the stomodæal opening, slightly lateral and posterior to it and forms the rudiments of the pedal glands. The invaginations proceed dorsally and very slightly anteriorly within the mass of the foot. Gradually, they become

narrower at the ventral but broader and rounded at the other end, and within a short time, two depressions appear at the broader dorsal end, dividing this region into three incomplete lobes (Fig. 2). The cells of the rudiments are oval, take up light stains and resemble the ectoderm cells at the beginning, but very soon, the cells of the broader portion of the invaginations become elongate-oval, take up deep stains and thus differ markedly from the ectoderm cells.



FIGS. 1-4. Fig. 1. A sagittal section passing through a pedal gland invagination of a 2.5 mm. embryo (7 days). Fig. 2. Same as that of Fig. 1 of a 3.25 mm. embryo (9 days). Fig. 3. A transverse section of the pedal gland of a 4 mm. embryo (11 days). Fig. 4. A median sagittal section of a 3 mm. (advanced) embryo (15 days) showing the median pedal gland and the slime canal. *pdgli*, Pedal gland; *pdgn*, Pedal ganglion; *slc*, Slime canal.

With an enlargement in size, the glands become anteroposteriorly directed, due to the forward prolongation of the foot [4-3.75 mm. (advanced) embryo, 11-13 days]. Posteriorly, it is subdivided into 3-4 rounded lobes (Fig. 3), while the anterior portion further narrows down to form a duct. The glands with their ducts move towards the middle but they are still quite apart from each other.

The glands, as they develop further, enlarge in size, move towards the middle and unite with each other to form a single median structure [3 mm. (advanced) embryo, 15 days], and opens to the exterior by a single aperture (Fig. 4). The lobes divide into lobules and the cells become glandular in nature, the rate of transformation being more on the ventral aspect. With the forward prolongation of the foot, the duct elongates and runs from the anterior opening to the posteriormost end of the gland, forming the slime canal. The anterior half of the slime canal remains naked, while the posterior half is surrounded by gland cells. New lobules develop from the existing lobules, and also from the wall of the slime canal by evaginations, and each of them becomes subdivided into a large number of alveoli. Towards the close of the embryonic development, the cells of all the alveoli and some of the cells of the lining epithelium of the slime canal become glandular, and the functional gland is formed sometime before hatching.

Little attention has been paid to the origin and development of the pedal gland. In the majority of gastropods, viz., *Vermetus* (Salensky, 1887), *Murex*, *Firolodia* (Korschelt and Heider, 1900), *Agriolimax* (= *Deroceras*; Carrick, 1939), *Pila* (Ranjah, 1942) and others, the pedal gland is ectodermal in origin, while the same is mesodermal in *Littorina* (Delsman, 1914), *Patella* (Smith, 1935) and *Haliotis* (Crofts, 1938). In all known cases it arises from a single invagination of the ectoderm of the foot. The gland in *Achatina* arises as a pair of ectodermal invaginations, which unite afterwards to form a single median gland, and in this respect *Achatina* differs from all other known species of gastropods.

Dept. of Zoology, KRISHNA CHANDRA GHOSE.  
City College, Calcutta,  
November 21, 1962.

1. Carrick, K., *Trans. Roy. Soc. Edin.*, 1939, 59 (3), 563.
2. Crofts, D. R., *Phil. Trans.*, 1938, 228 B, 219.
3. Delsman, H. C., *Tijdschr. Ned. Dierk.*, 1914, Ver. 13 (2), 170.
4. Korschelt, E and Heider, K., *T. B. Embryology of Invertebrates*, 1900, 4.
5. Ranjah, A. R., *Rec. Ind. Mus.*, 1942, 44 (3), 217.
6. Raven, C. P., *Morphogenesis: The Analysis of Mol-luscan Development*, 1958.
7. Salensky, W., *Arch. Biol.*, 1887, 6, 655.
8. Smith, F. G. W., *Phil. Trans.*, 1935, 225 B, 95.

## THE OCCURRENCE OF THE WOOD-BORING CRUSTACEAN, *SPHAEROMA TRISTE* HELLER ON THE INDIAN COAST

THE occurrence of *Sphaeroma triste*, a wood-boring isopod, has not been reported hitherto from the coastal waters of Indian Peninsula. During the course of a collection tour, 250 specimens of this species were collected from a semi-submerged tree-stump, drifting close to the Rameswaram coast.

The specimens presented all the characteristic features enumerated by Heller<sup>1</sup> and Barnard<sup>2</sup> with reference to the representatives of this species from Nicobar areas. The apically directed anterior extremity of the epistome is angular. The seventh paraeon segment is devoid of tubercles on the dorsal surface. Pleon possesses a pair of stout, conical, submedian tubercles and two backwardly directed lateral plates, fitting into the antero-lateral depressions of the telson. The dorso-median part of the telson is conspicuously convex with two prominent, submedian tubercles. The telsonic apex is angular, the edge being raised upwards. Rami of uropods are subequal and the outer border of exopod distinctly cut into eight pointed teeth, including the apical.

This species was first described by Heller on the basis of specimens collected from Nicobars. Barnard recorded this species from Camorta Islands and Lanchester<sup>3</sup> from Malaya Peninsula. Krishnapillai<sup>4</sup> has also given a description of the form collected by Barnard and lodged in the Indian Museum. Thus, this species appears to be of common occurrence in the centre of the Bay of Bengal and its present record from the coast of Rameswaram is of interest. The collection was made by the end of February 1962 when, according to Sewell,<sup>5</sup> there is a counter-clockwise circulation of surface current, preceding the east drift. It is just probable that the infested tree log was drifted from the centre of Bay of Bengal, i.e., from Nicobar areas.

My thanks are due to Prof. C. P. Gnanamuthu, Director, for his guidance. I also wish to thank Drs. S. Krishnaswamy and V. V. Srinivasan for their help and the Forest Research Institute, Dehra Dun, for financial assistance.

Marine Organisms Scheme, R. YESUDIAN GEORGE.  
Zoological Research Laboratory,  
University of Madras,  
Madras-5, November 23, 1962.

1. Heller, C., *Zool. Thail.*, 1899, 2, Ser. 3, 142.
2. Barnard, K. H., *Rec. Ind. Mus.*, 1936, 38, 177.

3. Lanchester, W. F., *Proc. Zool. Soc. Lond.*, 1902, **2**, 379.
4. Krishnapillai, N., *Monograph—Wood-boring Crustacea of India*, F.R.I., Dehra Dun, Govt. of India Press, 1961, p. 17.
5. Sewell, R. B. S., *Mem. Roy. Asiatic Soc. Bengal*, 1932, **9**, 286.

### THE SECRETORY CYCLE OF INVERTASE IN THE MIDGUT AND CAECA TISSUE OF *LOCUSTA MIGRATORIA* L. IN RELATION TO MOULTING

THE information on various aspects of the digestive physiology in insects (Uvarov,<sup>5</sup> Krüger,<sup>2</sup> Wigglesworth,<sup>7</sup> Roeder *et al.*<sup>3</sup> and Waterhouse<sup>6</sup>) does not make any mention of the secretory condition of the midgut in relation to moulting. However, in *Tenebrio molitor*, Dadd<sup>1</sup> has recently studied the protease activity of the midgut with a view to record variations with respect to age and feeding condition. In the present work *Locusta migratoria*—an insect with incomplete metamorphosis—was selected against *T. molitor* which undergoes complete metamorphosis, to record the variation of invertase activity in the midgut and caeca tissue of individual insects belonging to various age groups starting from the newly moulted 5th instar hoppers to the ten days old adults.

The method used for the determination of invertase activity was based on the colorimetric method of Sumner,<sup>4</sup> which was modified to work quantitatively.

It shows that in the newly moulted hoppers the invertase activity both in the midgut and caeca tissue extracts is negligible. Later, in the continuous presence of food both the tissues show remarkable increase in the invertase activity which reaches its maximum on the fourth post-moult day. Thereafter, it gradually declines and becomes almost negligible at the end of the nymphal period (Fig. 1). In the newly emerged adults also, the invertase activity in both the tissues remains negligible. It undergoes increase progressively up to the second or third post-emergent day; thereafter the activity fluctuates but the general trend is on the increase. These variations are more pronounced in the females than in the males.

It is suggested that the progressive increase of the invertase activity in *L. migratoria* after moulting is one of the facets of metabolic activity to provide enough reserve material for the growth of the hoppers and for laying down the new cuticle for the next moult. This slow

metabolic process is further speeded up after the emergence of the adult, perhaps to meet the

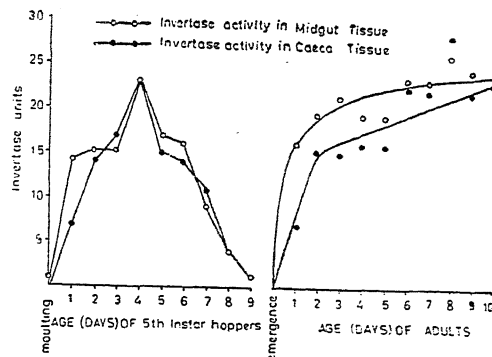


FIG. 1. Changes in invertase activity in the midgut and caeca tissue of 5th instar hoppers and adult *Locusta migratoria* L.

demand of material in greater quantity to cope with the growth and the maturation of the reproductive organs.

Entomology Section, MUMTAZ AHMAD KHAN.  
Department of Zoology,  
Aligarh Muslim University,  
Aligarh, November 8, 1962.

1. Dadd, R. H., *J. exp. Biol.*, 1956, **33**, 311.
2. Krüger, P., *Ergebn. Physiol.*, 1933, **35**, 538.
3. Roeder, K. D. *et al.*, *Insect Physiology*, John Wiley & Sons, New York, 1953.
4. Sumner, J. B., *J. biol. Chem.*, 1925, **65**, 393.
5. Uvarov, B. P., *Trans. R. ent. Soc.*, 1928, **76**, 255.
6. Waterhouse, D. F., *Ann. Rev. Ent.*, 1957, **2**, 1.
7. Wigglesworth, V. B., *The Principles of Insect Physiology*, Methuen & Co. Ltd., London, 1953.

### PERSISTING NUCLEOLI AND MICRONUCLEI IN THE MITOTIC CELLS OF *PISUM SATIVUM* LINN.

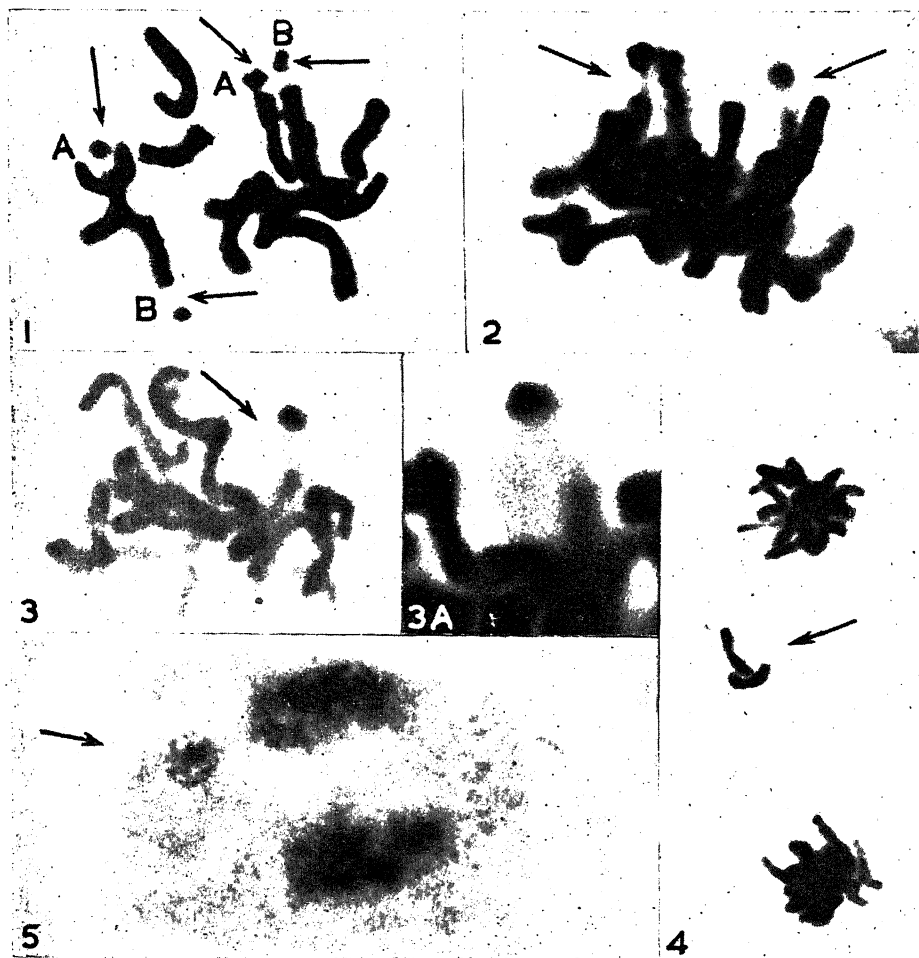
NUCLEOLI persisting till the metaphase of mitosis is common in Leguminosae.<sup>1-3</sup> These offer better opportunities for a critical study of the satellite-nucleolus association<sup>3,4</sup> than telophase or pro-phase stages. The earlier suggestion of Heitz that the nucleolar matter surrounds the SAT-thread is being confirmed by recent investigations.<sup>3,4,6,7</sup>

Differences of opinion exist whether in the mitotic cells of *Pisum sativum* Linn. (1) the nucleoli originate in relation with the centromere<sup>1</sup> or the satellite<sup>8</sup> and whether, (2) they persist till metaphase. In germinated seeds, the time when the maximum number of cells are in division in roots of a specific age is determined by the temperature of the environment. It was thought desirable, therefore, to

control these factors by transferring the seeds of a commercial variety kept in running water till the emergence of the radicles, to an incubator maintained at 30° C. When the germination had proceeded for another 16 hours, the tips of the roots were excised and fixed in formaldehyde-acetic-alcohol (1 : 1 : 3) for 24 hours. The above fixative gave good preservation and staining of the chromosomes as well as the nucleoli.<sup>3-9</sup> In material handled in this manner, large number of cells were consistently in division between 9-15 and 9-30 a.m.

soln. of hæmatoxylin (Dark Variety of Gurr) for 15 min., were teased into small bits in a drop of 45% acetic acid, squashed under a coverslip and sealed with paraffin wax.<sup>10</sup> The photographs presented are from such temporary mounts.

The two pairs of satellites are very clear in the metaphase plate presented as Fig. 1. One pair of SAT-grains (A in Fig. 1) is bigger than the other (B). In side views of the metaphase plate, the satellites could be clearly distinguished since they project out of the



FIGS. 1-5. Fig. 1. Metaphase with 2 pairs of satellites. Note the difference in the size of the satellites,  $\times$  ca. 2,050. Fig. 2. Metaphase. The satellites are seen projecting out of the group,  $\times$  ca. 2,250. Fig. 3. Persisting nucleolus at metaphase,  $\times$  ca. 2,450. Fig. 3 A. Nucleolar matter forms a collar around the SAT-thread,  $\times$  ca. 4,150. Fig. 4. Late anaphase. Note the pair of lagging chromosomes,  $\times$  ca. 3,500. Fig. 5. Telophase. Micronucleus with a nucleolus,  $\times$  ca. 1,550.

The fixed roots hydrolysed in N HCl at 60° C. for 10-15 min., mordanted in 4% ferric ammonium sulphate for 15 min., stained in a 0.5%

group (arrows in Fig. 2). Judged on that basis, the persisting nucleolus in Fig. 3 shows a very intimate relationship to the SAT-chromo-



some. The nucleolar matter forming a sheath to the SAT-thread in Fig. 3 A is reminiscent of similar observations in *Allium cepa*<sup>4</sup> and *Cicer arietinum*.<sup>3</sup> In the roots of *P. sativum* investigated, the nucleolus is associated with the satellite<sup>8</sup> and not the centromere.<sup>1</sup>

Several instances of lagging chromosomes and micronuclei were observed in the squashes of one of the roots. These became interesting because such anomalies have been observed previously only during meiosis in *P. sativum*.<sup>11, 12</sup> Figure 4 shows two lagging chromosomes. Since instances of polysomic cells with  $2n + 2$  or 3 chromosomes have been observed in the squashes of some roots, the lagging of chromosomes and the consequent micronuclei formation have to be considered as an accentuation of the rare mitotic abnormalities. The micronucleus in Fig. 5 has a well-defined nuclear membrane and a nucleolus. These Figures constitute perhaps the first record of the formation of micronuclei during mitosis in the normal roots of *P. sativum*.

Cytogenetics Laboratory, P. M. GOPINATH.  
Dept. of Biochemistry, M. K. SUBRAMANIAM.  
Indian Institute of Science,  
Bangalore -12,  
January 7, 1963.

1. Häkansson, A. and Levan, A., *Hereditas*, 1942, **28**, 436.

\*2. D'Amato-Avanzi, M. G., *Carvologia*, 1953, **5**, 133.

3. Meenakshi, G. and Subramaniam, M. K., *Proc Ind. Acad. Sci.*, 1963, **57B**, 73.

4. Subramayam, S. and Royan, S., *Curr. Sci.*, 1962, **31**, 244.

5. Heitz, E., *Planta*, 1931, **12**, 775.

\*6. Mulnard, J., *Arch. Biol.*, 1956, **67**, 485.

7. Pathak, G. N., *Ann. Bot. N.S.*, 1940, **4**, 227.

8. Morrison, J. W. and Shu Chang Lin, *Nature*, 1955, **175**, 343.

9. Rattenbury, J. A., *Stain Technol.*, 1952, **27**, 113.

10. Marimuthu, K. M. and Subramaniam, M. K., *Curr. Sci.*, 1960, **29**, 482.

11. Sutton, E., *Ann. Bot. N.S.*, 1937, **1**, 785.

12. Lamm, R., *Hereditas*, 1951, **37**, 356.

\* Not referred to in original.

### POTASSIUM NITRATE AND CARBOHYDRATE CONTENTS OF ARGEMONE MEXICANA LINN. AT DIFFERENT STAGES OF ITS GROWTH

High contents of potassium nitrate and carbohydrates along with other organic acids seem to be vital factors responsible for making *Argemone mexicana* a good soil amendment.<sup>1</sup> Therefore a comprehensive study of potassium nitrate and carbohydrates in the plant at different stages of its growth was undertaken.

The amount of potassium nitrate in the plant has been observed to rise steadily as the growth advances, the optimum amount being reached at the flowering stage. Naturally-dried plants, collected before rains, showed little difference in their potassium nitrate content as compared to the green plants. But when collected after rains, they showed a marked decrease in the content which might be attributed to the fact that the rain washes out potassium nitrate of the dry plants. It has also been noted that the dried and powdered plants do not lose amount of potassium nitrate even when stored for a considerable length of time, for about a year. Plants, reaching their maturity at lower height than the usual one, have been found to contain higher percentage of potassium nitrate. The amount of potassium nitrate in the plants has also been found to vary with the different localities where the plants were collected from, the variation ranging from 1.1 to 2.9%. Relation between soil nutrients and potassium nitrate present in the plant is under investigation.

Carbohydrate contents of *A. mexicana* differed little at the different stages of its growth. Percentage of total reducing sugars (calculated as glucose)<sup>2</sup> after hydrolysis remained almost the same.

The results are summarised in Table I.

TABLE I

Average height of the plant	KNO <sub>3</sub> (dry wt. basis)	Total reducing sugars after hydrolysis (Zero moisture basis)
	%	%
2.5 cm.	1.0	8.6
15 cm.	1.1	9.3
20 cm.	1.6	9.8
45 cm. (Flowering stage)	2.0	10.4
90 cm. (Fully matured stage)	2.0	10.4
30 cm. (Flowering stage)	2.7	9.7
30 cm. (Fully matured stage)	2.7	9.7
Naturally-dried plants	2.5	10.3
Naturally-dried plants collected after rains	0.2	10.0
Stored powdered plants	2.3	9.2

*Water-soluble polysaccharides.*—The dried plant material, after successive hot extraction with methanol and acetone, was finally extracted with water. Polysaccharides were precipitated from the water extract by the addition of alcohol. Yield (crude product), 1.8%. Precipitated product was hydrolysed with  $\text{NH}_4\text{SO}_4$  for 8 hours. The hydrolysate, after usual neutralization, revealed the presence of galactose and arabinose by paper chromatography, using

n-butanol-acetic acid-water (4 : 1 : 5) as irrigant and aniline hydrogen phthalate as spraying agent.

**Alkali-soluble polysaccharides.**—The residue, obtained after water extraction, was treated with 4% aqueous sodium hydroxide solution and stirred. Alkali extract was neutralized with acetic acid and precipitated with alcohol. Yield (crude product), 4.8%. Precipitates were subjected to hydrolysis as described earlier. Chromatographic examination showed the presence of galactose, xylose and an unidentified saccharide.

The authors are thankful to Shri S. P. Singh for his help in the collection of plant material.

National Botanic Gardens, M. I. H. FAROOQI,  
Lucknow, India, K. N. KAUL.  
November 15, 1962.

1. Misra, P. S., Bhakuni, D. S., Sharma, V. N. and Kaul, K. N., *J. sci. & industr. Res.*, 1961, **20 B**, 186.
2. A.O.A.C., *Official and Tentative Methods of Analysis*, 5th Ed., Washington, 1940.

### AN ANALYSIS OF ARTESIAN WELL-WATER FOR MICRO-ORGANISMS

IN South Arcot District, Madras State, there is a belt of underground water impounded under pressure. In recent years, artesian wells have been sunk to tap this water source for irrigating agricultural crops. Continued use of this water for irrigating rice crops in the area has resulted in the deterioration of the soil conditions and crop yield. With a view to examine the suitability of the water for irrigation purposes chemical analyses of the water samples were carried out, the details of which are being reported elsewhere. In the course of these studies it was observed that the samples invariably contained high concentrations of hydrogen sulphide and iron. In order to examine whether any significant populations of micro-organisms are associated with these substances, studies were made and the results are briefly reported here.

For these studies water samples were collected from artesian wells sunk in different localities of the tract and with wide differences in their age. The samples were collected in sterile bottles and brought to the laboratory. They were immediately taken up for microbiological analysis using the dilution plate technique with soil extract agar for estimating the total microbial population, ferric ammonium citrate-nitrate agar for estimating the iron-precipitating bacteria

and Van Delden's medium for examining the presence or otherwise of the sulphate-reducing bacteria, following the procedure given by Allen.<sup>1</sup> In all ten water samples were examined and the results are given in Table I.

TABLE I  
*Microbial population of the water samples from artesian wells*

Location of the artesian well	Age of the well in months	Total microbial population: $10^4$ /ml.	Iron bacteria $10^4$ /ml.	Presence or absence of sulphate-reducing bacteria
Mazharayanallur	.. 18	18.8	0	+
Mudikondanallur-1	.. 8	5.1	3.0	+
do. 2	.. 31	0.4	0	+
Kootambuli	.. 27	4.5	2.8	+
Perur 1	.. 19	0.5	0	+
do. 2	.. 32	0.6	0	+
Iyengiveedu	.. 38	4.8	0	+
Pudaiyur	.. 36	4.8	2.8	+
Andipalyam	.. 5	3.9	2.4	+
Veerantapuram	.. 5	3.8	2.4	+

The samples were analysed chemically, following the procedure given by the A.O.A.C.<sup>2</sup> and it was found that the water samples contained on an average: bicarbonate 450 p.p.m. but no carbonate, sulphate 64 p.p.m., calcium 115 p.p.m., magnesium 32 p.p.m., sodium 57 p.p.m., iron 109 p.p.m. and  $H_2S$  1190 p.p.m. The pH of the samples was on the alkaline side ranging from 7.0 to 8.2.

As could be seen from Table I there are wide variations in the total microbial population of the water samples. Also in five out of ten samples there were large numbers of iron precipitating bacteria, their population reaching as high as 63% of the total population. These bacteria are heterotrophic, precipitating iron from various organic compounds and according to Starkey<sup>3</sup> they play an important role in the transformation of iron in soil. It is quite likely that the continued activity of this group of bacteria in soil bring forth changes in the soil conditions which are harmful. In the rice fields irrigated continuously with the water for more than two years iron gels are found invariably floating on the water. In all the samples sulphate-reducing bacteria were present and there seems to be some correlation between the  $H_2S$  content of water and the sulphate-reducing bacteria. It is probable that the bacteria are responsible for the release of large quantities of hydrogen sulphide, the accumulation of which

in the stagnant water of paddy fields may lead to harmful effects. The age of the wells varied from 5 to 38 months and the water has been flowing continuously during these periods. There seems to be no correlation between the age of the wells and the total microbial population of the water. Perhaps the microbial populations of the underground water vary from place to place.

Annamalainagar, S. CHANDRASEKHARAN.  
Annamalai University, S. KALIYAPERUMAL.  
Department of Agriculture, G. RANGASWAMI.  
Madras State, November 19, 1962.

1. Allen, O. N., *Experiments in Soil Bacteriology*, Burgess Publ. Co., Minneapolis, U.S.A., 1951.
2. Anonymous, *Official Methods of Analysis*, Association of Official Agricultural Chemists, Washington, D.C., 1950.
3. Starkey, R. L., *Soil Sci.*, 1955, 79, 1.

#### VERTICAL ZONATION AND SEASONAL VARIATION IN THE GROWTH OF PORPHYRA ON VISAKHAPATNAM COAST

BASED on some dried specimens in Prof. Iyengar's collection from the Madras harbour, Boergesen<sup>1</sup> first reported the occurrence of *Porphyra* in India. Subsequently Sreeramulu<sup>2</sup> found this alga growing in the littoral region on Waltair coast. *Porphyra* was not observed on any part of the Visakhapatnam coast before 1950. A few plants were found for the first time on this coast in 1951 and during the next three years it gradually established itself on boulders in the intertidal region. The present communication deals with the vertical distribution and seasonal variation in the growth of *Porphyra* observed in the year 1961 on this coastline.

*Porphyra* occurs on smooth as well as *Chthamalus* encrusted boulders in the midlittoral zone (of Stephenson's scheme<sup>3</sup>) which are daily covered and uncovered by the tides. In the early stages of its annual growth it begins to appear here and there on the shells of *Cellana* and *Chthamalus* and it grows gradually without mixing with the other algae and forms distinct dark mahogany-red coloured bands on the surfaces of boulders exposed to wave action. The range of vertical distribution of these bands in the intertidal region is worked out following the method described by Evans.<sup>3</sup> The height of *Porphyra* band during the period of its maximum development in 1961 is found to be about one metre with well-marked upper and

lower limits (Fig. 1), extending approximately from 0.4 to 1.4 metres above the zero level of the tide.

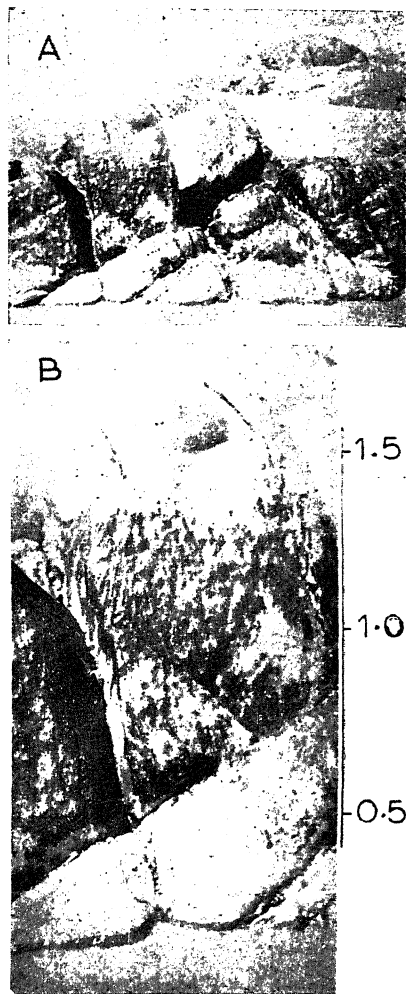


FIG. 1. Photographs of a boulder on Visakhapatnam Coast showing the *Porphyra* band. A. entire band; B. close-up of a portion of the band with the scale of height (in metres) above the zero level of the tide.

Data on the seasonal variation in the quantity of *Porphyra* growth have been obtained by marking five quadrats (each with a side of 25 cm.) at different vertical heights in the midlittoral zone on the surfaces of some selected boulders in February, the beginning of its annual growth period in 1961. The area covered by the alga in each quadrat is measured at fifteen-day intervals. The average values of percentage cover per quadrat estimated from the actual results are plotted in Fig. 2 to show the

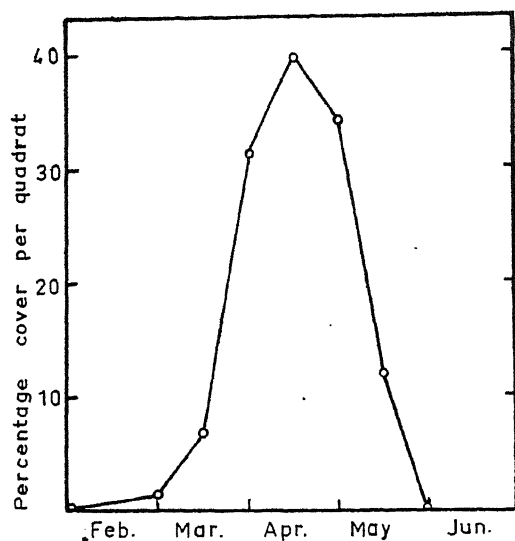


FIG. 2. Seasonal variation in the growth of *Porphyra* on Visakhapatnam Coast in 1961.

seasonal variation in the quantity of the algal mass observed from the beginning till the end of its growth period in 1961. Although *Porphyra* disappeared from all the quadrats in the month of June, a few plants were observed in the vicinity till the end of August. After the disappearance of the thalli produced in the growing season in 1961, no traces of *Porphyra* are found on these boulders till the alga reappeared in the next year on the shells of *Cellana* and *Chthamalus*. Drew and Richards<sup>2</sup> have reported that *Porphyra* exists in the *Conchocelis*-phase in certain barnacles and suggested that these infested barnacles provide a perpetual reserve from which fresh thalli develop year after year. The possibility of its perennation in the *Conchocelis*-phase during its unfavourable periods on Visakhapatnam coast is suggested by its appearance on *Cellana* and *Chthamalus* in the early stages of its annual growth.

On this coastline the growth period of *Porphyra* in 1961 extended from March to May. Sreeramulu<sup>6</sup> reported May to August as the growth period of this alga in the year 1952. In 1962 we have observed the growth period extending from January to April. The year to year variations observed on the same coastline are probably due to the variations in the environmental factors operating in the intertidal region in different years.

The seasonal growth period in which *Porphyra* flourishes luxuriantly on this coast is found to be the period when most of the other algal

forms growing in the intertidal region are in a degenerating condition. An examination of the daily tidal records of this coast for this part of the year revealed the occurrence of lowest tides in the year. As such this part of the intertidal region is exposed to air for a comparatively longer time during this period than in the rest of the year. Highest air temperatures are also recorded during these months. The luxuriant growth of *Porphyra* during this period indicates its capacity to resist conditions of desiccation better than other algae growing at this height. In the vertical distribution also it has been reported<sup>3-5</sup> that *Porphyra* displays considerable variation in different regions showing its tolerance to factors associated with submergence and emergence.

Results reported here are collected as part of a scheme work which was financed by the Council of Scientific and Industrial Research, New Delhi, to whom we express our thanks.

Botany Department, M. UMAMAHESWARA RAO.  
Andhra University, T. SREERAMULU.  
Waltair, September 15, 1962.

*Added in proof* : Prof. George F. Papenfuss has now identifies this species as *Porphyra vietnamensis* Tanaka et Ho.

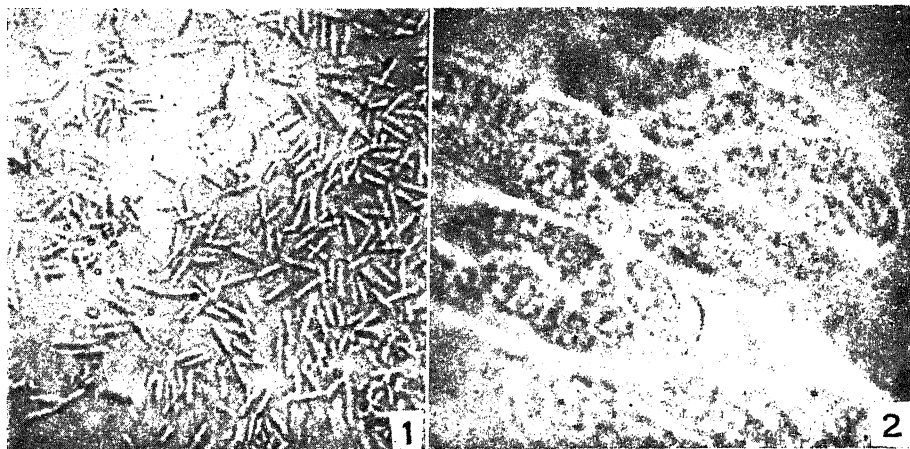
1. Boergesen, F., *J. Indian bot. Soc.*, 1937, **16**, 311.
2. Drew, K. M. and Richards, K. S., *J. Limn. Soc. (Bot.)*, 1953, **55**, 84.
3. Evans, R. G., *J. Ecol.*, 1947, **34**, 273.
4. Grubb, V. M., *Ibid.*, 1936, **24**, 392.
5. Lewis, J. R., *Proc. Zool. Soc. Lond.*, 1953, **123**, 481.
6. Sreeramulu, T., *Sci. and Cult.*, 1952, **18**, 285.
7. Stephenson, T. A. and Stephenson, A., *J. Ecol.*, 1949, **37**, 289.

#### ASSOCIATION OF A NEW SPECIES OF *PHOMA* WITH *PLEOSPORA HERBARUM* (PERS.) RAHB,

THE plants of *Citrus maxima* growing around Allahabad manifested severe leaf-spotting of dark-gray colour in August 1957. Isolation of the black fruiting bodies from the diseased regions yielded the perithecia of *Pleospora herbarum* as well as pycnidia of *Phoma* sp. The herbarium specimen as well as the culture of the latter organism were sent to C.M.I., Kew, but it could not be attributed to any of the existing species of *Phoma*. Due to abnormally elongated size (*vide* Fig. 1) of the conidia it is being described as a new species, *viz.*, *Phoma nainiense* sp. n.

#### Morphological character of the isolate

Hyphae very closely septate, light brown 5.2–7.6  $\mu$  wide; pycnidia black, 215–340  $\times$  131–



FIGS. 1-2. Fig. 1. Showing long and cylindrical conidia of *Phoma nainiense* ( $\times 347$ ) recovered from the diseased leaves of *Citrus maxima*. Fig. 2. Showing the asci and ascospores of *Pleospora herbarum* ( $\times 506$ ).

259  $\mu$ , conidia hyaline, cylindrical, very much elongated,  $13.0-15.6 \times 2.9 \mu$ .

*Phoma nainiense* spec. nov.—Læsiones fusce griseæ huius speciei diametiantes 2.0-3.0 cm. in foliis *Citri maxima*. Hyphæ arctissime septatæ, pallide brunneæ  $5.2-7.6 \mu$  latæ; pycnidia nigra, sphærica vel paulum oblonga, erumpentia,  $215-340 \times 131-259 \mu$ , sporis hyalinis cylindricis valde elongatis  $13-15.6 \times 2.9 \mu$ .

Parasitice insidet foliis *Citri maxima*. Cultura posita in C.M.I., Kew, sub numero 82767 et in sectione mycologica universitatis Allahabadensis.

*Possible relationship between Pleospora herbarum and Phoma nainiense:*

The leaves of *Citrus maxima* were inoculated with *Phoma nainiense*. The inoculated leaves were covered with polyethylene bags to avoid external pathogens. The bags were opened at different intervals. It was found that pycnidia of *Phoma nainiense* were produced after 20-24 days of inoculation. Two months later the perithecia of *Pleospora herbarum* were developed in the lesions which were incited by *Phoma nainiense*. In culture, however, the possibly related forms could not be obtained from each other but in view of the fact that the leaves of *C. maxima* inoculated with *Phoma nainiense* yielded the perithecia of *P. herbarum* also it is considered that *Phoma nainiense* is imperfect stage of *Pleospora herbarum*.

The author is thankful to Professor R. N. Tandon for the encouragement. The help received from Dr. J. C. F. Hopkins, Director, C.M.I., Kew (England) and Prof. H. Santapau is gratefully acknowledged.

Department of Botany, K. S. BILGRAMI.  
University of Allahabad, September 4, 1962.

## ADDITIONS TO THE FUNGI OF INDIA

THIS paper deals with three forms of fungi new for India, namely, *Humicola stellatus* var. *giganteus* var. nov., *Oncopodium panici* Hudson and *Myrothecium stratisporum* Preston. Their diagnostic characters are as follows:

### 1. *Humicola stellatus* var. *giganteus* var. nov.

Infection spots light-brown to brown, interspersed with hyphæ and aleuriophores. Hyphæ pale-brown to brown,  $3.5-7 \mu$  broad. Aleuriophores arising laterally from aerial hyphæ, solitary, varying from  $7-14 \times 5.25-7 \mu$ , occasionally with a septum at the base; aleuriospores borne singly at the tips of aleuriophores, hyaline and sub-globose to begin with, dark-brown and stellate at maturity with 4-12 projections including the hilum. Size of the aleuriospores vary, minimum diameter  $10.5-14 \mu$  and maximum diameter (including projections)  $14-38.5 \mu$ .

Infectionis maculæ pallide brunneæ vel brunneæ, hyphis et aleuriophoris intermixtæ. Hyphæ e pallide brunneis brunneæ,  $3.5-7 \mu$  latæ. Aleuriophora lateraliter surgentia e hyphis aereis solitaria,  $7-14 \times 5.25-7 \mu$ , nonnumquam septo ornata ad basin; aleuriosporæ singulariter insidentes apicibus aleuriophorum, hyalinæ et sub-globosæ initio, ad maturitatem vero fusce brunneæ et stellatæ, ornatae 4-12 projectionibus hilo incluso; magnitudo sporarum multum variat, diam. minimo  $10.5-14 \mu$ , maximo  $14-38.5 \mu$ .

The above characters show the fungus resembling with *Humicola stellatus*, recently described by Bunce (1961) but differing from it in bearing larger aleuriophores and aleurio-

spores having comparatively greater number of projections. Hence a new varietal name, viz., *H. stellatus* var. *giganteus* is being proposed. This fungus was found growing on dead leaf-sheaths and on dead leaves at the basal regions of *Bothriochloa pertusa* A. Camus and *Dichanthium annulatum* Stapf.

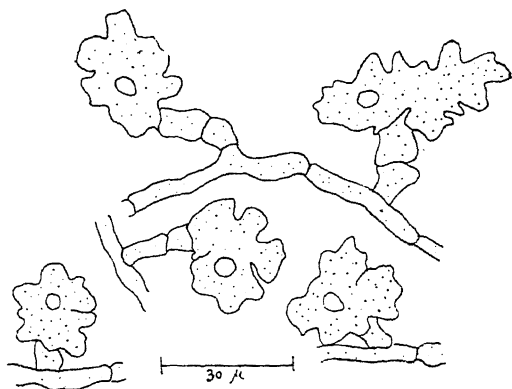


FIG. A. *Humicola stellatus* var. *giganteus* var. nov. Attachment of aleuriophores at the tips of Aleuriophores.

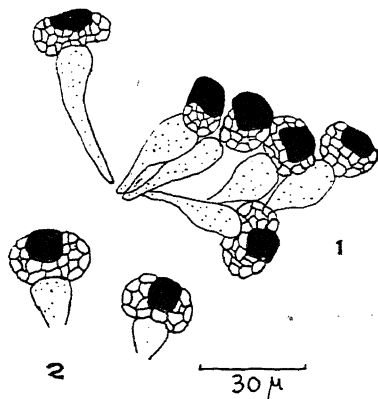


FIG. B. *Oncopodium panici* Hudson. (1) Attachment of conidia at tips of conidiophores. (2) Conidia.

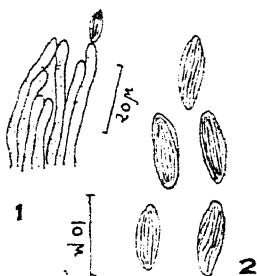


FIG. C. *Myrothecium stratisporum* Preston. (1) Conidiophore; (2) Conidia.

## 2. *Oncopodium panici* HUDSON

Spots minute, scattered, brown when young becoming dark at maturity. Sporodochia superficial, flattened, hemispherical measuring 96–176  $\mu$ , bearing 33–94 conidiophores, conidiophore unicellular, hyaline, 21–35  $\mu$  long, 3.5–4  $\mu$  broad at the base and 7–11.6  $\mu$  at the tip where they swell like a bladder, bearing single terminal conidium; conidia clathrate having a dome-shaped cap of pigmented cells directly above the conidiophore, most of the conidia provided with a broad rim of colourless cells about 2–5 cells wide or sometimes only 1–3 celled. Conidia flattened in vertical plane, measuring 17.5–24.5  $\times$  10.5–14  $\mu$ . It was collected on decaying leaves and leaf-sheaths of *Bothriochloa pertusa* A. Camus, *Dichanthium annulatum* Stapf. and *Cynodon dactylon* Pers. and has been recently described by Hudson (1961).

## 3. *Myrothecium stratisporum* PRESTON

Spots scattered dark-brown to begin with, becoming black at maturity, sporodochia up to 250  $\mu$ . Conidiophores sub-hyaline to pale-olive-green, greenish-brown in mass, slenderly club-shaped, frequently verrucose, phialides measuring 17–42  $\times$  3.5–3.8  $\mu$ , conidia small, smooth, sub-fusoid, guttulate, broadest slightly below the middle, apex pointed, epispore smooth when young, becoming fluted usually with fifteen ridges arranged longitudinally and sometimes spirally, sub-hyaline to begin with becoming smoky olive-brown at maturity, measuring 7–14  $\times$  2.8–3.5  $\mu$ .

The fungus tallies with the description given by Preston (1948) and it was collected on dead leaves and leaf-sheaths of *Cynodon dactylon* Pers.

The slides of these fungi are in author's collection in the Department of Botany, Banaras Hindu University.

Grateful thanks are due to Dr. R. Y. Roy for his guidance, Prof. R. Misra, for facilities and to Rev. Dr. H. Santapau for the Latin diagnosis.

Department of Botany,  
Banaras Hindu University,  
Varanasi-5 (India),  
September 10, 1962.

P. K. KHANNA.

1. Bunce, M. E., *Trans. Brit. mycol. Soc.*, 1961, 44 (3), 372.

2. Hudson, H. J., *Ibid.*, 1961, 44 (3), 406.

3. Preston, N. C., *Ibid.*, 1948, 31, 271.

### LEAF-SPOT OF APPLE-BLOSSOM

A new bacterium inciting spots on leaves of Apple-blossom (*Hibiscus Rosa-sinensis* L.) was noticed in the nurseries of Adelaide, South Australia.

The symptoms of the disease were manifested as minute round spots varying in size from 1-3 mm. surrounded by a distinct halo of about 2-3 mm. in size which in turn is surrounded by anthocyanin pigments (Fig. 1). The descrip-

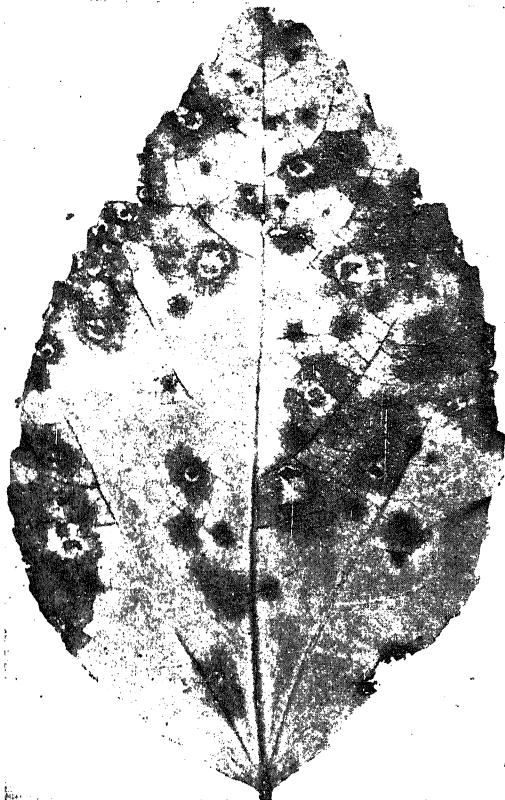


FIG. 1. Artificially inoculated leaf.

tion of the pathogen named as *Pseudomonas hibiscicola* sp. nov. is as follows:

Short rods with rounded ends, single but rarely in pairs, measuring  $1.8 \times 0.9 \mu$ ; gram-negative; capsulated; non-spore-forming; not acid fast; colonies on King's agar plates are circular with entire margin, shining, pearly white, measuring 6 mm. in 8 days, fairly good growth on yeast-chalk-agar; copious flowing growth on potato cylinders with no change in the colour; gelatin liquefied and starch hydrolysed; plain milk cleared with peptonization; litmus milk turned alkaline.  $\text{NH}_3$  and  $\text{H}_2\text{S}$  from peptone not produced; M.R. and V.P. tests positive; no indol; production of green

fluorescence on Clara's and King's medium. In a peptone-free medium, acid without gas from dextrose, sucrose, xylose and glycerol; no growth in *d*-arabinose, lactose, raffinose, mannitol, dulcitol and salicin; aerobic; thermal death-point about  $52^\circ \text{C}$ . Optimum temperature for growth between  $27\text{--}30^\circ \text{C}$ . Pathogenic to *Hibiscus Rosa-sinensis* L. Found in Adelaide, South-Australia.

Plant Pathological Laboratory,  
College of Agriculture,  
Poona-5, August 24, 1962.

L. MONIZ.

### A NEW RECORD OF AN ASCIGEROUS MOULD FROM INDIA

DURING the course of investigation of soil fungi of a grassland of Varanasi, an ascogenic fungus new to this country was frequently isolated from the rhizosphere of *Saccharum spontaneum* Linn. It first appeared on Waksman medium and was transferred to oat meal agar, Czapek's and PDA for detailed study.

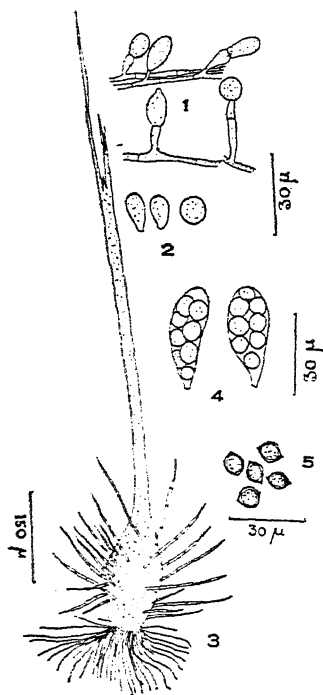
The important characters of the fungus are production of branched mycelium, bearing globose to subglobose conidia after 3-4 days, sometimes with a small papilla at their tips. After 8-10 days of inoculation, dark brown, superficial, ovoid, membranous, spiny-walled perithecia with long beak, attached to the substratum with well-developed rhizoids are observed, beaks straight or sometimes slightly curved at base, cylindrical and filamentous, filaments composing the beak frequently separating at the tips and of irregular length, setae of the perithecial wall, brown, rigid, septate, tapering, asci octosporous, clavate, evanescent, ascospores hyaline when young, changing to dark brown with age, subglobose, apiculate.

The fungus in its diagnostic features resembles *Chaetoceratostoma longirostre* described by Farrow (1955)\* but differs from that in bearing smaller perithecial setae, beak and ascospores. Further, conidial formation, which has not been reported by Farrow, has been observed in this case.

The diagnostic character of the fungus is as follows:

Colonies on oat meal agar medium growing moderately reaching a diameter of 4 cm. in 6 days at room temperature ( $30^\circ \text{C}$ .), hyphae well developed, yellowish in colour, septate, bearing conidia on the conidiophores which arise at the lateral side of the hyphae, conidia globose to subglobose, thick-walled, rarely with a papilla at the tip  $8\text{--}14 \times 7.5\text{--}14 \mu$ , conidiophores

septate, mostly unbranched, rarely branched  $3.5-53 \times 2.5-3.5 \mu$ , perithecia produced abundantly after 8 days, dark brown, ovoid, membranous, spiny-walled with a prominent beak at the tip, beaks composed of several compactly aggregated filaments, frequently separating at the tips and of irregular length, perithecia measuring from  $122.5-210 \times 77-125 \mu$ , setae  $122-315 \mu$  long and  $2.5-3.5 \mu$  broad at the base, beak  $928-1280 \mu$  long, tapering,  $24-32 \mu$  in diameter at base to  $3.5-12 \mu$  at tip, asci clavate with eight spores, evanescent measuring from  $16.5-38.5 \times 14-17.5 \mu$ ; ascospores subglobose, apiculate, hyaline, at the young stage, becoming dark-brown at maturity,  $9-10.5 \times 7.5-9 \mu$ .



FIGS. 1-5. Fig. 1. Attachment of conidia at tips of conidiophores. Fig. 2. Conidia. Fig. 3. A perithecium. Fig. 4. Asci. Fig. 5. Ascospores.

The author is grateful to Dr. R. Y. Roy for his guidance, to Prof. R. Misra for providing laboratory facilities and to the Government of India for the award of a Senior Research Training Scholarship.

Department of Botany, R. R. MISHRA.  
Banaras Hindu University,  
Varanasi-5, September 10, 1962.

\* Farrow, W. M., *Mycologia*, 1955, 47, 416.

## STUDIES IN LEGUMINOSAE

### 3. Notes on *Lourea* Neck. and *Uraría* Desv.

THE genus *Lourea* Neck. is no longer recognised and most of its species are transferred to *Christia* Moench. *Lourea paniculata* Wall. ex Benth. and *L. campanulata* Benth. are changed to *Christia paniculata* (Wall. ex Benth.) Thoth. and *C. campanulata* (Benth.) Thoth. respectively.

The occurrence of *Uraría prunellaefolia* Grah. ex Baker in Bastar, Madhya Pradesh, constitutes a new record for this area, for it is known so far only from N.W. Province, Kumaon, Upper Gangetic Plain, Eastern Himalayas, Assam and Burma.

Bakhuizen van den Brink while critically reviewing the Malaysian species of the genus *Lourea* Neck. (Reinwardtia, 1961, 6, 89) commented that another generic name is required for this taxon because it is no longer recognised. After Necker the name *Lourea* was first used by St. Hilaire (*Nouv. Bull. Soc. Philom.*, Paris, 1812, 3, 193) and it was proposed to reject *Moghania* St. Hill. Further, *Lourea* Desv. (*J. de Bot.*, 1813, 1, 122) was again later homonym. Bakhuizen van den Brink therefore suggested that *Lourea* should be placed under the generic name *Christia* Moench. (*Suppl. Meth. Pl.*, 1802, 39) which is the first synonym of *Lourea* Neck. Accordingly he transferred all the four Malaysian taxa of *Lourea*, viz., *L. vespertilionis* Desv., *L. obcordata* Desv., *L. parviflora* Schindl., and *L. zöllingeri* Schindl., to *Christia* Moench. Of the four species, *Christia vespertilionis* (L.f.) Bakh. f., and *C. obcordata* (Poir.) Bakh. f. occur also in India. Baker (*Fl. Brit. Ind.*, 1876, 2, 154) included *Lourea paniculata* Wall. ex Benth. and *L. campanulata* Benth., from Burma along with them. These two species therefore require nomenclatural changes and they are discussed here.

*Lourea paniculata* Wall. ex Benth. is a distinct species from Ava, Burma. The plant is distinguished by unifoliate leaves, twice as broad as long and the terminal or lateral racemose panicles. Unfortunately, Wall. Cat. 5673 from the type locality is not present in the Calcutta Herbarium. Its nomenclature is: *Christia paniculata* (Wall. ex Benth.) Thoth. comb. nov. *Lourea paniculata* Wall. [Cat. 5673, nom. nud. 1831-32] ex Benth. in *Miq. Pl. Jungh.*, 1852, 215; Baker in *Fl. Brit. Ind.*, 1876, 2, 154. Distribution: Burma, Taong-dong mountains, Ava.

*Lourea campanulata* Benth. is again well known from Burma which Wallich enumerated (Wall. Cat. 5685) as *Uraría campanulata*. The



diagnostic features of this plant are the presence of three leaflets of which the terminal one is the largest and the paniculate inflorescence with densely pubescent branchlets. The correct name of this plant is: *Christia campanulata* (Benth.) Thoth. comb. nov. (*Uraria campanulata* Wall. Cat. 5685, nom. nud. 1831-32) *Lourea campanulata* Benth. in *Miq. Pl. Jungh.*, 1852, 215; Baker in *Fl. Brit. Ind.*, 1876, 2, 155. *Distribution*: Burma, Ava, Shan States, Minbu and Ruby Mines.

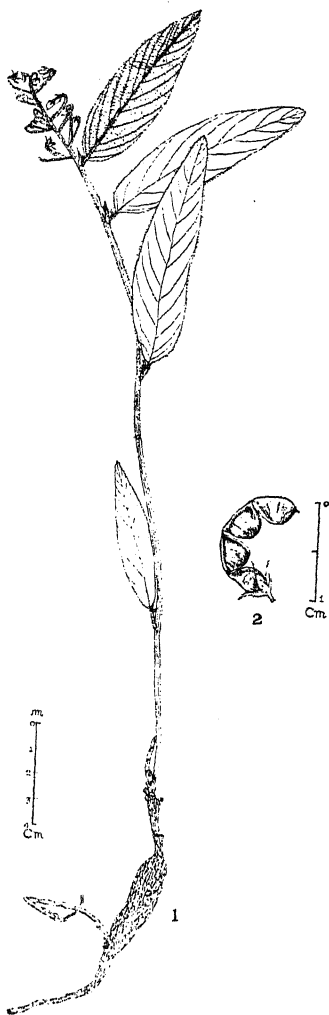


FIG. 1. *Uraria prunellaefolia* Grah. ex Baker (1) Plant with the inflorescence; (2) Pod showing 4, one-seeded, indehiscent joints.

Burma: Ava, Taong-dong mountains, 1826—Wall. Cat. 5685 (Isotype in Herb. CAL): Shan State, Laikaw, 1893—Abdul Khalil s.n. (CAL): Minbu, Plango road-side, Nov. 1902—Shaik

Mokim 676 (CAL): Ruby Mines, Thabeitkyin, 100 m., Nov. 1908—Lace 4403 (CAL): Meiktila, without precise locality, 1887—Collett 6 (CAL).

*Uraria prunellaefolia* Grah. ex Baker (*Fl. Brit. Ind.*, 1876, 2, 157) is a distinct species, characterised by its unifoliate leaves, terminal short racemes, flowers on long pedicels which are clothed with stiff hairs and 3-4 jointed lomentum. This species has been reported so far from N. West Province (Sinpar, Gorakhpur—Harsukh); Kumaon (Thomson); Upper Gangetic Plain (Kheri, Oudh—Inayat); Eastern Himalayas (Griffith); Assam (Khasi—Clarke, Fischer; Lower Assam—Kurz; Orang jungle—Chatterjee) and Burma (Kachin Hills—Shaik Mokim). This plant has recently been collected from Bastar, Madhya Pradesh by Tiwari (Baniajaon block on the eastern side under Sal saplings, Bastar, Madhya Pradesh, Apr. 1955—Tiwari 209 in Herb. CAL) which therefore is a new record.

*Description*.—An erect undershrub in sandy loam. Root swollen and fusiform. Stem shortly pubescent. Leaf unifoliate, alternate, stipulate; stipule prominent, triangular, striate, subulate, hairy, 6-7 mm. long; leaflet oblong-lanceolate, 8.8-10.1 cm. long, 2-2.3 cm. wide, entire, ciliate, acute, rarely mucronulate, rounded at base, subcoriaceous, glabrous above, puberulous below especially on the main nerves and reticulations; lateral nerves 8-10 pairs; petiolule short, 5-7 mm. long, hairy. *Inflorescence* a raceme, terminal, 4.5 cm. long; rachis and pedicels covered with stiff, white hairs and hooked brown hairs; nodes of raceme tumid with three pedicellate flowers; bract large, prominent striate, hairy, caducous, bracteoles absent; pedicel up to 1.5 cm. long. *Calyx* tube short, brownish hairy. *Pod* a lomentum consisting of 2-4, one-seeded, indehiscent joints; joints black, polished, sometimes minutely puberulous.

Central National Herbarium, K. THOTHATHRI.  
Botanical Survey of India,  
P.O. Botanic Garden, Howrah, August 13, 1962.

#### CHLOROPHYLL MUTANTS IN *PENNISETUM TYPHOIDEUM* (BAJRA) INDUCED BY GAMMA-RAYS

PURE seeds of the three varieties of bajra (RSK, RSJ and Nokha) were got treated in 1961 with four doses each, the doses being 5,000 r, 10,000 r, 20,000 r and 30,000 r of gamma-rays. The gamma-garden facility of the Indian Agricultural Research Institute, New Delhi, utilised for this purpose is gratefully acknowledged.

Observation made on the germinated selfed ear progenies of both the treatments as well as

TABLE I  
Chlorophyll mutation frequency, types of chlorophyll mutants and their numbers observed in the  $M_2$  generation of *Pennisetum typhoideum* (Bajra) treated with gamma-rays

Material	Treatment	No. of $M_1$ plant progenies	No. of segregating progenies	No. of $M_2$ plants scored	No. of chlorophyll mutants	Types of chlorophyll mutants							% of $M_1$ families segregating
						*A	X	VA	S	XA	T	M	
1. RSJ ..	5,000 r	11	1	160	1	..	..	..	1	..	..	..	9.09
2. do. ..	10,000 r	78	14	2244	63	16	12	1	10	19	3	2	17.94
3. do. ..	20,000 r	208	13	1798	31	1	7	..	9	5	3	6	6.25
4. do. ..	30,000 r	11	1	37	1	1	..	..	..	..	..	..	9.09
5. RSK ..	20,000 r	90	7	798	16	5	1	..	2	3	..	..	7.77
6. Nokha ..	5,000 r	14	1	130	19	8	5	..	2	..	2	2	7.14
7. do. ..	10,000 r	10	1	115	1	1	..	..	..	..	..	..	10.00
8. do. ..	20,000 r	7	1	110	7	..	7	..	..	..	..	..	14.28

\* A—Albina; X—Xantha; VA—Viridoalbina; S—Striata; XA—Xanthalba; T—Tigrina and M—Maculata.

controls reveal that seven types of chlorophyll mutants occur in the treatments. These types are classified according to a scheme proposed by Gustafsson<sup>1,2</sup> and are given in Table I. The percentage of chlorophyll mutants in the total number of  $M_2$  plants is 2.57. Percentage of  $M_1$  plant progenies and number of plants scored are also given in Table I. From the data it is seen that all treatments except RSK 5,000 r, 10,000 r and 30,000 r and Nokha 30,000 r (all these not included in Table I) segregated for chlorophyll mutants. Controls did not throw out any chlorophyll mutants in any of the varieties mentioned above. Some green lethals also appeared in this generation but as they were not chlorophyll mutants they have not been included in this study.

The tigrina, maculata and striata types of mutants observed in these experiments with Bajra were of non-lethal nature. One of the striata had the midrib white, the rest of the leaf being green. In other cases white stripes were distributed longitudinally on the leaf-blade. The maculata type were stunted in growth. Albina and Xantha proved lethal within the same time, i.e., 8 days after their germination.

The somatic chromosomes of various types of mutants were studied in root-tip squash preparations. No difference could be detected either in the karyotype or the chromosome number ( $2n=14$ ) of these varieties.

Our thanks are due to Sri. T. C. Kala, Director of Agriculture, Jaipur, Rajasthan, for giving us facilities.

Section of Economic Botany. R. P. CHANDOLA.  
Govt. Agril. Res. Farm, M. P. BHATNAGAR.  
Durgapura, Jaipur. MISS INDU TOTUKA.  
Rajasthan, September, 4, 1962.

### MEIOTIC STUDIES IN SOME MEMBERS OF THE TRIBE PANICEAE

CYTOTAXONOMIC studies of grasses have been undertaken here to find out the chromosome numbers in the grasses found in this area. Darlington and Wylie's *Chromosome Atlas*<sup>1</sup> reveals that for many of these grasses the chromosome number has not been worked out so far. The present account deals with the meiotic behaviour of eight species belonging to seven genera of the tribe Paniceae. Certain new facts regarding their chromosome numbers have been brought to light.

The material was collected from field and fixed either in alcohol acetic acid or alcohol propionic acid (3 : 1), the latter being preferred in many cases. The pollen mother cells were squashed in acetocarmine or propionocarmine respectively in the two cases. Iron acetate was sometimes added to the fixative to get better results. Counts, camera lucida drawings and photographs were made immediately after squashing.

In most of the cases the division was synchronous, but in some cases it was not so. Two or three stages could be available in the same anther, e.g., metaphase I and anaphase I commonly occur together. This might be due to anaphase I taking over the metaphase I quite rapidly. In some cases the reports of chromosome counts are new in this investigation, while in other cases they either confirm the previous report or give a different chromosome count.

*Alloteropsis cimicina* is reported here to be tetraploid ( $n=18$ ) with the base number  $x=9$ . This is the first chromosome count in this species. In *Echinochloa colonum*, the present study confirms one of the previous counts,  $2n=36$ ,<sup>2</sup>  $2n=48$ ,<sup>3</sup>  $2n=54$ <sup>4</sup> and  $2n=72$

1. Gustafsson, A., *Lunds Univ. Årsskr.*, 1940, **36**, 1.
2. Bhaskaran, S. and Swaminathan, M. S., *Genetica*, 1961, **32**, 2000.

TABLE I  
Meiotic behaviour of some grasses of the tribe Paniceae

Sl. No.	Plants	Collection No.	Gametic No. $n$	Base No. $x$	Ploidy	
†1	<i>Alloctropis cinnam</i> (Linn.) Stapf.	..	20	18	9	Tetraploid
2	<i>Echinochloa colonum</i> (Linn.) Link.	..	3	27	9	Hexaploid
*3	<i>Panicum psilopodium</i> Trin.	..	7	18	9	Tetraploid
4	<i>Paspalidium flavidum</i> (Retz.) A. Comus.	..	16	27	9	Hexaploid
5	<i>Paspalum scorbulatum</i> Bojer.	..	22	20	10	Tetraploid
6	<i>Pennisetum typhoides</i> (Burm.) Stapf.	..	30	7	7	Diploid
7	<i>Setaria glauca</i> (Linn.) P. Beauv.	..	5	18	9	Tetraploid
†8	<i>Setaria tomentosa</i> (Roxb.) Kunth.	..	2	18	9	do.

† Count reported for the first time ; \* Count differs from the previous report.

(E. K. Janaki Ammal, unpublished). This grass is hexaploid with  $n=27$  and  $x=9$ .FIGS. 1-8. Fig 1. *Allotheropsis cinnicna*, Diakinesis 18 bivalents. Fig 2. *Echinochloa colonum*, Diakinesis 27 bivalents. Fig 3. *Panicum psilopodium*, Diakinesis 18 bivalents. Fig 4. *Paspalidium flavidum*, Diakinesis 27 bivalents. Fig 5. *Paspalum scorbiculatum*, Anaphase I 20 chromosomes on each pole. Fig 6. *Pennisetum typhoides*, Metaphase I 7 bivalents. Fig 7. *Setaria glauca*, Diakinesis 18 bivalents. Fig 8. *Setaria tomentosa*, Metaphase I 18 bivalents.

In *Panicum psilopodium* Ramanathan<sup>5</sup> gave  $2n=54$ , which differs from the present count of  $n=18$ . This is to be taken as tetraploid with  $x=9$ . *Paspalum scorbiculatum* is tetraploid having  $n=20$  and  $x=10$ . This confirms the count of  $2n=40$  given by Avdulov.<sup>6</sup> In *Paspalidium flavidum*  $n=27$  confirms the report given by Raman et al.,<sup>11</sup> and is therefore hexaploid with  $x=9$ . *Setaria tomentosa* is tetraploid with  $n=18$  which is the first chromosome count in this species with  $x=9$ .

In *Pennisetum typhoides* different somatic counts of  $2n=14-17$ <sup>7</sup> and  $2n=14$ <sup>8</sup> are reported. The present count also gives  $n=7$  showing that the grass is diploid with base number of  $x=7$ .

In *Setaria glauca*,  $2n=36$ <sup>9</sup> and  $2n=72$ <sup>10</sup> are known. The present material gives  $n=18$ , and is therefore tetraploid with base number  $x=9$ .

The results of the investigation are given in Table I.

The author is grateful to Professor R. P. Roy of Patna for his guidance and to Professor K. S. Bhargava for his encouragement.

Botany Department,  
University of Gorakhpur,  
Gorakhpur, September 17, 1962.

P. K. GUPTA.

1. Darlington, C. D. and Wylie, A. P., *Chromosome Atlas of Flowering Plants*, London, 1955.
2. Brown, W. V., *Bull. Torrey Bot. Cl.*, 1950, **77**, 63.
3. Krishnaswamy, N. and Raman, V. S., *Curr. Sci.*, 1949, **18**, 376.
4. de Wet, J. M. J., *Cytologia*, 1954 **b**, **19**, 97.
5. Ramanathan, K., *Curr. Sci.*, 1950, **19**, 155.
6. Avdulov, N. P., *Dnezn. Vsesoyuz. Ssed. Bot.*, 1928, **1**.
7. Li, C. H. and Li, H. W., *Chinese J. Sci. Agric.*, 1943, **1**, 139.
8. Krishnaswamy, N. and Ayyangar, R., *Proc. Ind. Acad. Sci.*, 1941, **13 B**, 9.
9. Avdulov, N. P., *Bull. Appl. Bot. Genet. etc. Suppl.*, 1931, **43**.
10. Brown, W. V., *Amer. Jour. Bot.*, 1948, **35**, 283.
11. Raman, V. S., Chandrasekharan, P. and Krishnaswami, D., *Curr. Sci.*, 1959, **28**, 453.

# GENETICS OF SEEDLING RESISTANCE TO RACE 122 OF BLACK RUST OF WHEAT

RACE 122, whose occurrence was first reported in 1952 by Gokhale and Patil,<sup>1</sup> is one of the most virulent races of black rust met with in

1. Gokhale, V. P. and Patil, B. P., *Curr. Sci.*, 1952, 21(9), 250.
2. Prasada, R. and Joshi, L. M., *Indian Phytopath.*, 1961, 14, 23.

TABLE I

Mode of inheritance of seedling reaction in  $F_2$  of six wheat crosses to race 122 of black rust

Cross	Number of seedlings			$\chi^2$	P value	Mode of Segregation
	Resistant	Susceptible	Total			
E. 2842 $\times$ N.P. 710 ..	110	154	264	0.0293	0.90-0.80	27 R : 37 S
E. 2342 $\times$ N.P. 823 ..	94	114	208	0.770	0.50-0.30	27 R : 37 S
E. 2842 $\times$ N.P. 824 ..	111	169	280	0.7433	0.50-0.30	27 R : 37 S
E. 3123 $\times$ N.P. 824 ..	154	210	364	0.0035	0.98-0.95	27 R : 37 S
E. 3123 $\times$ N.P. 824 ..	139	197	336	0.922	0.50-0.30	27 R : 37 S
E. 3123 $\times$ P.C. 281 ..	217	86	303	1.849	0.20-0.10	3 R : 1 S

India. All the wheat varieties under cultivation at present in this country as well as the parents used in breeding for rust resistance so far are susceptible to this race. Although according to Prasada and Joshi<sup>2</sup> the race is not widely distributed at present, it may, however, suddenly become prevalent at some future date to cause epiphytotic as has happened with biotypes like 15 B, etc., elsewhere. As such it was thought necessary to start breeding work for resistance to this race. Systematic screening of the available genetic stocks for resistance to this race was taken up and some varieties like Yaqui 53 (YxE-T), 2257-15C-1C-5C-1C, Mexico (E. 2842); Kenya 318 A.J. 4. A-1 (E. 3123); Kenya-Ploughman, 318.0.3. B. 2 (E. 3133); 1231-23 (Regent 975 - 11  $\times$  Giza 139<sup>2</sup>) (E. 3158); 220/39. T. vulgaris var. delfi (E. 3236) and Kentana-Baga  $\times$  Frontana-Urquiza, II-944-3 b-6 b-1 b-1 R (E. 4458), etc., were found to be resistant. Crosses were made between these strains and four cultivated varieties and the segregation observed in the  $F_2$  progenies is given in Table I.

An  $F_2$  ratio of 27 R : 37 S was obtained in all the three crosses where E. 2842 was the resistant parent, thereby showing that this parent possesses three dominant complementary genes for seedling resistance to race 122. Similar ratios were obtained in the crosses E. 3123  $\times$  N.P. 824 and E. 3133  $\times$  N.P. 824. The segregation ratio of 3 R : 1 S in the cross E. 3133  $\times$  Pb.C. 281 indicated that Pb.C. 281 may be carrying two dominant complementary factors which are common with those present in E. 3133 so that segregation occurred only for 1 gene.

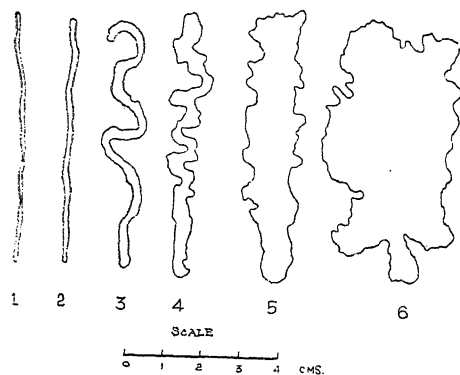
Division of Botany,  
Indian Agri. Research  
Institute, New Delhi-12,  
September 22, 1962.

M. V. RAO.  
O. P. MAKHLJA.  
R. K. AGRAWAL.

## OCCURRENCE OF *ENTEROMORPHA* AT KHARGONE (M.P.)

*Enteromorpha* is a green alga belonging to the order Ulotrichales. Though it is of common occurrence as marine form at Madras, Okha, Dwarka and Cape Comorin, its occurrence in fresh-waters has rarely been reported in India. The author has collected it from Khargone, a place in the west Nimar District.

The collections were made from the local Kunda river in the months of March and April. It inhabits shallow waters. The specimens include various forms of thalli varying from narrow filamentous to broad ribbon-like structures (Figs. 1 to 6).



FIGS. 1-6. Figs. 1-2. Narrow filamentous stages. Figs. 3-4. Intermediate stages. Figs. 5-6. Broad ribbon-like thalloid stages.

The author is thankful to Prof. M. O. P. Iyengar for confirming the identification of the alga.

Department of Botany,  
Govt. Science College,  
Jabalpur, October 22, 1962.

A. B. SEERWANI.

# SOME INTERESTING FEATURES IN THE MALE GAMETOPHYTE OF *VIOLA ODORATA* LINN.

*Viola odorata* Linn., the common garden violet, bears cleistogamous, semi-cleistogamous and chasmogamous flowers. It was noticed that these flowers failed to set seed at Jodhpur. A study, undertaken to investigate the cause

of this sterility, has revealed some interesting features of the male gametophyte.

The anther wall consists of an epidermis, an endothecium, 3-4 ephemeral middle layers and a glandular tapetum (Fig. 1). The cells of the endothecium develop fibrous thickenings which also extend to the sub-epidermal layers on either side of the appendage, probably suggesting



FIGS. 1-7. Development of male gametophyte of *Viola odorata* Linn. Fig. 1. L.s. part of young anther,  $\times 1,750$ . Fig. 2. Same, showing microspore tetrads and degenerating middle layers,  $\times 1,070$ . Fig. 3. Pollen grains; note the viable and non-viable grains,  $\times 102$ . Figs. 4, 5, 6. Smear showing furrowing in microspores,  $\times 1,190$ . Fig. 7. L.s. part of anther; note germination of pollen grains *in situ* and fibrous thickenings in hypodermal cells of the appendage,  $\times 102$ .

that the appendage is the sterile part of the anther (Fig. 7).

Microsporogenesis is simultaneous and cytokinesis takes place by furrowing. Tetrahedral, decussate and isobilateral types of tetrads are produced (Fig. 2). In addition to such tetrads, 5-10 or more spores per mother cell have also been recorded. The polysporic condition is the result of division of the microspores of a tetrad. Mitotic figures of the microspore nuclei have not been observed, but their elongated and lobed appearance suggests that they divide amitotically. Similarly, amitotic divisions of the microspore nuclei have been reported in sterile plants of *Sesamum orientale*.<sup>1</sup>

Pollen grains attain the two-celled stage, and the male gametophyte thereafter presents an array of interesting features. Pollen grains germinate *in situ*; most of the pollen tubes, however, remain within the pollen sac and only a few escape out of the dehiscence gap in the anterior region of the anther (Fig. 7). These fail to reach the stigma of the cleistogamous, semi-cleistogamous and chasmogamous flowers. Polysiphonic germination and branched pollen tubes are also frequent.

A queer and perhaps unreported phenomenon is the repeated division of some of the microspores after they have developed the exine. The division takes place by furrowing and, as the furrows grow inwards, the pollen grains become dumb-bell shaped (Figs. 4, 5). The furrows meet at the centre resulting in two spores (Fig. 6). This process may not be followed by the division of the nucleus; hence some of the grains are enucleate. Repeated furrowing of these yield a large number of small sterile pollen grains. The microspores which do not divide further are large, viable or non-viable (Fig. 3). The percentage viability of the pollen grains varies in flowers of different seasons. It is considerably high (92-90%) in July and August and gradually decreases to 20-10% in January and February.

We are thankful to Professor C. V. Subramanian for facilities and encouragement.

Department of Botany, DALBIR SINGH.  
University of Rajasthan. SANTOSH GUPTA.  
Jodhpur, October 23, 1962.

## FLORAL ANATOMY OF *MONSONIA SENEGALENSIS* GUILL. AND PERR.

BANCROFT AND DICKSON (1930) examined the anatomy of flower of *Pelargonium*. Later, Dickson (1936) studied the vascular anatomy of the carpel in *Geranium robertianum* and Dawson (1936) described the floral anatomy of *Geranium maculatum* and *Erodium cicutarium* and discussed the nature of the carpel in the Primulaceae and Polemoniaceae respectively. The present study on the floral anatomy of *Monsonia senegalensis*, a member of the Geraniaceae, has been made with special reference to obdiplostemony and the origin and behaviour of carpellary marginals.

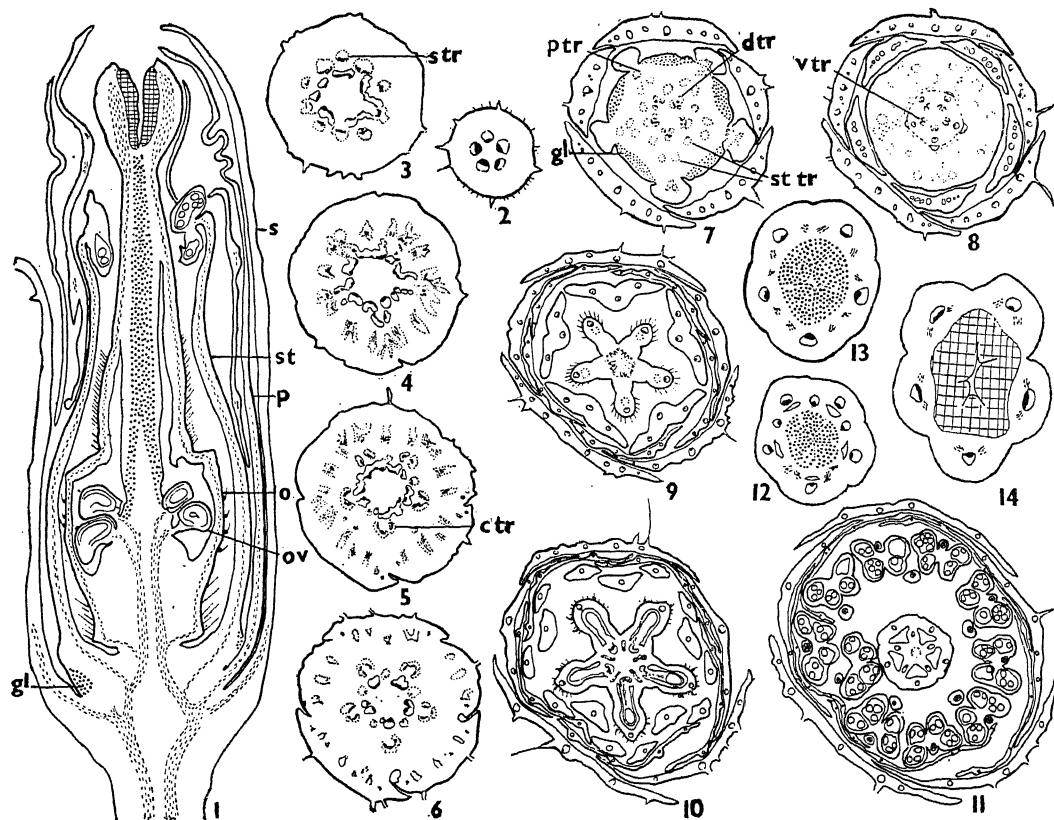
The stele of the pedicel is composed of five conjoint, collateral bundles with narrow pith rays (Fig. 2). It gives rise to midrib and five commissural traces which in turn branch during their course and form the marginals of the sepals (Figs. 3, 4) as in *Geranium maculatum* and *Erodium cicutarium* (Dawson, 1936). Both the marginals and the midrib traces of the sepal branch further so that five to seven bundles finally enter the sepal (Figs. 5, 6). The receptacular stele organises immediately and forms five conjoint traces which soon differentiate into a petal midrib and two traces for antipetalous stamens at the periphery of the receptacle (Figs. 6-8). This condition differs from the situation in *Pelargonium* (Bancroft and Dickson, 1930) and *Geranium maculatum* and *Erodium cicutarium* (Dawson, 1936) where the petal trace is fused with the staminal trace. These are next followed by the five alternating traces for the inner whorl of antiseptalous stamens (Figs. 6, 7). The petal traces branch as they enter the organs concerned and form five to seven bundles. There are five receptacular glands alternating with petals (Fig. 7). At a higher level the staminal traces get segregated into five groups of three each at the periphery of the receptacle and later enter the pentadelphous filament (Figs. 8, 9). Simultaneously each triangular bundle of the receptacle organises into a median dorsal and two basal ventrals (Figs. 7, 8) which later branch and form the two marginals along the septal radii (Fig. 9). Both the ventrals and the marginals of adjacent carpels fuse to form five ventrals along the dorsal radii and five marginals along the septal radii (Fig. 10). However, the marginals enter the septa (Fig. 11), branch at the tip of the style (Figs. 12, 13) betraying their double nature as in *Geranium maculatum* (Dawson, 1936) and ultimately anastomose

1. Kumar, L. S. S. and Abraham, A., *Indian J. Genet. Pl. Breeding*, 941, 1, 41.

with the dorsals in the styler branches (Fig. 14) which are stigmatosed adaxially. There are two superposed ovules in each locule borne on an axile placenta (Fig. 1).

receives a dorsal, two ventrals and two marginals which are not commissural.

We are indebted to Dr. K. Subramanyam, Deputy Chief Botanist, Botanical Survey of



FIGS. 1-14. Fig. 1. L.s. flower bud showing arrangement of floral parts (semidiagrammatic),  $\times 15$ . Figs. 2-14. T.s. flower bud at various levels from pedicel upwards. Figs. 2-11,  $\times 15$ . Figs. 12-14,  $\times 36$ . (ctr, conjoint trace; dtr, dorsal trace; gl, gland; o, ovary; ov, ovule; p, petal; ptr, petal trace; s, sepal; str, stamen trace; st, stamen; str, staminal trace; vtr, ventral trace.)

The flower of *Monsonia senegalensis* is pentacyclic, pentamerous and bisexual. The sepal receives one midrib and two marginals which are commissural in origin. The traces of petals and the outer whorl of ten antipetalous stamens are conjoint in the beginning. Later, each conjoint trace gets resolved into a petal and two staminal traces suggesting the de-doubling of the outer whorl of stamens. These are followed by five traces of the inner whorl of antisepalous stamens. The obdiplasty in this case is neither caused by the mechanical pushing of the inner antipetalous whorl of stamens to the periphery nor caused by the suppression of the third whorl of stamens (see Puri, 1951). It is only the result of staminal bundles being conjoined with the petal midrib. Each carpel of the pentacarpellary syncarpous ovary

India, for helpful suggestions and to Professor C. V. Subramanian, Head of the Department of Botany, University of Rajasthan, for encouragement and facilities.

Department of Botany, H. S. NARAYANA.  
University of Rajasthan, P. K. ARORA.  
Jodhpur, India, December 19, 1962.

1. Bancroft, H. and Dickson, J., *Studies in Floral Anatomy. I. The Nectary of Pelargonium*, Oxford, 1930.
2. Dawson, M. L., "The floral morphology of the Polemoniaceae," *Amer. Jour. Bot.*, 1936, **23**, 501.
3. Dickson, J., "Studies in floral anatomy. III. An interpretation of the gynoecium in the Primulaceae," *Ibid.*, 1936, **23**, 385.
4. Puri, V., "The role of floral anatomy in the solution of morphological problems," *Bot. Rev.*, 1951, **17**, 471.

# RHIZOPUS SEXUALIS FROM SOIL IN INDIA

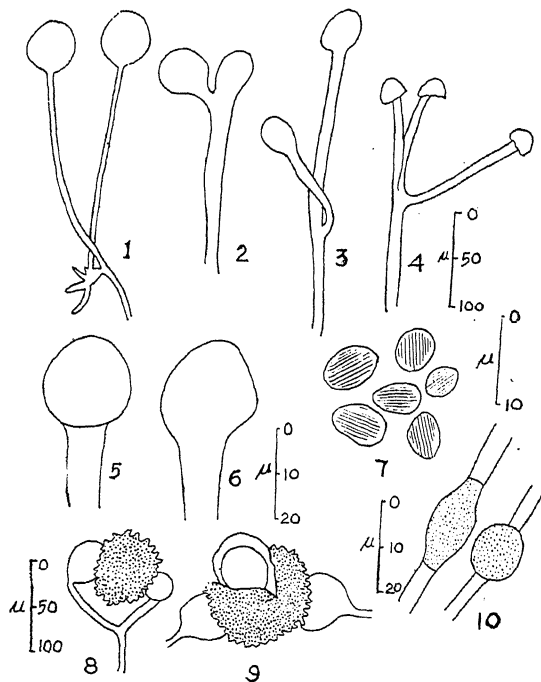
ONLY two out of the several known species of *Rhizopus*, viz., *R. sexualis* (Smith) Callen and *R. homothallicus* Hesse and Ellis are homothallic. The former has always been reported from rotting strawberry or cherries and has never been reported from soil. In the several isolations of Mucorales made by the author a homothallic species of *Rhizopus* was isolated which resembled with the detailed description of *R. sexualis* recently given by Hesse and Ellis (1961). However, this isolate produced chlamydospores in abundance in both P.D.A.\* and S.M.A.† media which were found to be absent in the same media by Hesse and Ellis (1961). It is being reported here for the first time from India and is the first record from the soil.

*Rhizopus sexualis* (SMITH) CALLEN (FIGS. 1-10).

Colonies on P.D.A. and S.M.A. at first white sterile aerial mycelium but becoming gray on aging. Sporangiophores brown, variable in length, simple or branched dichotomously, arising from stolons with simple or branched rhizoids at the base. Sporangia globose, blackish  $30-135.6\mu$  in P.D.A. but  $15-90\mu$  in S.M.A. in diameter; leaving no collar at the base, columella brown  $20-82.5 \times 22.5-75\mu$  in P.D.A. and  $12.5-67.5 \times 15-62.5\mu$  in S.M.A., globose, oval, spatulate or dorsiventrally flattened. Sporangiospores brown, subglobose to oval  $4.4-11 \times 4.4-9.9\mu$ , wall striate. Zygospores  $42.5-95$  (parallel to suspensors)  $\times$   $50-106.5\mu$  (at right angles to the suspensors) in P.D.A.,  $42.5-80 \times 37.5-95\mu$  in S.M.A., globose or compressed between suspensors, brown in colour, scattered throughout the aerial mycelium, exospore echinulate, projections blunt or pointed, sometimes bent at their tips, up to  $10\mu$  long; endospore comes out of the exospore under pressure. Chlamydospores globose to oval, smooth, hyaline mostly single and intercalary,  $12.8-37.5 \times 10-30\mu$ , numerous within 4-5 days.

Grateful thanks are due to Dr. B. S. Mehrotra for his guidance and to Professor R. N. Tandon

for the laboratory facilities. This paper constitutes a part of a project "Studies on



FIGS. 1-10. Fig. 1. Two typical sporangiophores. Figs. 2-4. Three sporangiophores showing branching. Figs. 5-6. Two columellae. Fig. 7. Sporangiospores. Fig. 8. Zygospore. Fig. 9. A crushed zygospore with endospore coming out. Fig. 10. Two chlamydospores.

Mucorales" supported by PL 480 Grant FG-In-121.

Botany Department,  
University of Allahabad,  
Allahabad (India),  
October 23, 1963.

USHA BAIJAL.

1. Hesse and Ellis, "Notes on Mucorales, especially *Absidia*," *Mycologia*, 1961, 53, 406.

\* P.D.A.: Potato (Peeled), 200 gm.; dextrose, 20 gm.; agar agar, 20 gm.; dist. water, 1,000 ml.

† S.M.A.: Dextrose, 40 gm.; asparagine, 2 gm.;  $\text{KH}_2\text{PO}_4$ , 0.5 gm.;  $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ , 0.25 gm.; thiamine hydrochloride, 0.5 mg.; agar agar, 20 gm.; dist. water, 1,000 ml.



## REVIEWS

**Random Variables and Probability Distributions** (2nd Edition). By H. Cramér. (No. 36, *Cambridge Tracts in Mathematics and Mathematical Physics*), 1962. Pp. 110. Price 21 sh.

The Cambridge Tract *Random Variables and Probability Distributions* by H. Cramér has been out of print for many years. By publishing a second edition of it, the Cambridge University Press has done a great service to workers in Probability theory. The concise nature of the tract does not naturally permit of elaboration or addition of much new material. Thus the contents of the tract are practically the same as those of the first edition of it.

The author's another book, *Mathematical Methods of Statistics*, first published in 1945, contains some material in common with this tract, and has therefore partly reduced the difficulty of the latter being out of print. Yet, the gap has remained in respect of Asymptotic Expansions and Stochastic Processes, and hence there continued to be a demand for the second edition of the book under review.

The author himself has clearly stated in the preface the differences between this and the first edition. In this edition is set right an error in Theorem 11 on the necessary and sufficient condition for a sequence of distribution functions to converge to a distribution function in terms of the corresponding sequence of characteristic functions. This theorem in its corrected form, containing the restriction 'for every  $t$ ', was already given by the author under the name of 'Continuity Theorem for characteristic functions in  $R_1$ ' in Chapter 10 of his book *Mathematical Methods of Statistics*.

Theorem 12, needed for treatment of asymptotic expansions, has been replaced by another with simplified treatment by the use of functions of bounded variation.

It should be noted that a certain characteristic function is first defined, and multivariate normal distribution is introduced as the distribution corresponding to it. In the second edition, there is a change in terminology in Chapter 8. Homogeneous processes are now termed processes with stationary and independent increments.

The normal distribution and the Central Limit Theorem form the central theme of the book, much of the earlier material converging to it, and a good part of the later resulting from it.

K. NAGABHUSHANAM.

**An Introduction to Elementary Particles.** By W. S. C. Williams. (Academic Press, New York and London), 1961. Pp. vi+406. Price \$11.

Prof. Williams of the Clarendon Laboratory, Oxford, has written this book mainly for research workers in the field of experimental elementary particle physics and it is intended to present an introduction to theoretical methods and ideas employed. There has been made extensive use of symmetry properties and of their associated conservation laws, in the field of elementary particles. They give considerable insight into the behaviour of elementary particles without requiring an extensive background of quantum mechanics for their understanding. Field theory plays an important part and a descriptive chapter on it is included, which enables the use of Feynman diagrams and to talk about propagators and vortices without involving oneself in complicated matrix element calculations. Dispersion theory is also covered.

We have chapters on angular momentum, partial wave analysis, space properties of vector fields, transitions, symmetry and isotopic spin, the pi-meson, polarization of elementary particles, field theory, parity, time reversal and charge conjugation, beta decay, strange particles, and recent topics in elementary particle physics. Advanced students would be greatly benefited by a careful study of this book.

B. DASANNACHARYA.

**Physics of the Nucleus.** By M. A. Preston. (Addison, Wesley Publishing Co., Reading, Massachusetts, U.S.A.), 1962. Pp. x + 661. Price \$15.

The book is divided into five parts. In the first, entitled fundamental properties of nuclei, we have a discussion of the two nucleon force and of those gross properties of the nuclei which can be understood with only the simplest ideas of nuclear structure. Here we have chapters on internucleon forces and one each on size of nuclei, nuclear moments and shapes, and binding energies. Part II, entitled nuclear models, deals with single particle model, individual particle model, correlations in nuclear matter, and collective nuclear motion. Part III deals with the electromagnetic properties of nuclei. Radioactivity is handled in Part IV dealing with alpha and beta particle activities,

It includes the whole new field of parity non-conservation, with force responsible for beta decay being designated as weak interaction to distinguish it from the much stronger interactions of the pi-meson field and of the electromagnetic field, the beta decay force, however, being much stronger than the gravitational force. In the final Chapter V, on nuclear reactions, we have treatment of cross-sections by the method of collision matrix. Physically interesting situations are well discussed in terms of the *R. matrix* applicable when details of the many body systems are not known.

Prof. Preston has given us an authoritative presentation of the current position of nuclear structure and dynamics at specialist level. Although the author modestly claims that his book is primarily for the graduate student, there is no doubt, that, like the work of Blatt and Weisskopf, it would become a standard. The book is, according to the author, neither experimental nor theoretical. There is no doubt whatever that it is very much to theory. The book deserves great recognition.

B. DASANNACHARYA.

**Liquid Rockets and Propellants.** Edited by Loren E. Bollinger, Martin Goldsmith and Alexis W. Lemmon, Jr. *Progress in Astronautics and Rocketry*—Vol. 2. American Rocket Society Series. (Academic Press, New York and London), 1960. Pp. 682. Price \$ 6.50.

This publication is the second of the series of volumes on *Progress in Astronautics and Rocketry* sponsored by the American Rocket Society. The first volume dealt with solid propellant rockets and the present one deals with liquid rockets and propellants.

If the 1950's may be called the epoch of supersonic jet aircraft, the 1960's may be said to belong to space rockets. During the last five years great progress has been made in manned earth satellites and the launching of rockets to the Moon and neighbouring planets. The day is not far off when gigantic rockets will carry an expedition to the Moon.

Remarkable advances have been made in the exploration of space by rocket vehicles equipped with very complicated instruments to measure temperature, pressure, density, ion concentration and cosmic ray intensities in the upper atmosphere of the earth and beyond. All this has been possible due to recent developments in rocket technology which has made great strides. Alongside these technological developments, we have also increased our basic know-

ledge of the processes taking place in rocket engines. The present volume contains papers describing these achievements presented at the Propellants, Combustion and Liquid Rockets Conference held at the Ohio State University in July 1960. It also contains other papers submitted to the Society for publication. The topics covered are high-altitude performance of rockets, combustion dynamics and technological developments in the design and construction of rockets.

The subject-matter is presented in six sections. The first section deals with simulated high-altitude testing of rockets on the ground and contains an account of experimental investigations carried out on exhaust diffusers for rocket engines. The second section deals with instrumentation for study of combustion processes particularly instability conditions. There are three sections dealing with the combustion of liquid propellants, reaction kinetics and selection of propellants respectively. The last section deals with design aspects of rocket engine.

Of particular interest are two papers by Dr. G. V. R. Rao on a concept relating to diffusers for testing rocket nozzles and a new type of expansion-deflection type of rocket nozzle. As regards combustion instability, the aspects which are exhaustively dealt with relate to the measurement of pressure fluctuations, heat transfer and the study of transient effects. Spray deflagration, fuel burning in air and oxygen, decomposition processes during combustion interactions, chemical reactions in the rocket motor and recombination effects are important fields of study.

The publication contains much useful information for the research worker as well as for the development engineer and technologist and will no doubt be a useful addition to the growing technical literature on liquid rockets and propellants.

P. N.

**Collection of Problems in Physical Chemistry.** By Bares, Cerny, Fried and Pick. (Addison-Wesley Publishing Company, Inc.), 1962. Pp. vii + 608. Price \$ 9.75.

The present work is the translation of the original in Czech. This is a unique text of its kind. The only other work of this kind known to the reviewer is *Physico-Chemical Calculations* by Guggenheim and Prue. But the present one differs from the latter in having larger number of illustrations and in having a large number of problems at the end of

each section with answers. The illustrations and problems cover almost the entire field of Physical Chemistry. The topics considered are: Atomic Structure and the Fundamentals of Quantum Mechanics, Kinetic Theory of Gases, Ideal Gases, Fundamentals of Thermodynamics, States of Matter, Phase Equilibrium, Chemical Equilibrium, Electro-chemistry, Reaction Kinetics, Surface Phenomena, Colloidal Systems, Molecular Structure and Physical Properties. The total number of solved illustrations is 172. The illustrations have mainly been taken from published literature.

For fundamental grounding in various aspects of Physical Chemistry, this book will be an asset to advanced students and research workers in Physical Chemistry. It would be very beneficial to use this text for supplementing teaching of Physical Chemistry at advanced level. To a certain extent it can be used for supplementing training even in practical Physical Chemistry particularly from the viewpoint of the analysis of the experimental data.

The only criticism that can be made against the book is that the treatment of certain sections such as Quantum Mechanics and Electro-chemistry could have been a little more advanced.

R. P. RASTOGI.

**Oxygenases.** Edited by O. Hayaishi. (Academic Press, Inc., New York), 1962. Pp. xii + 588. Price \$ 17.50.

Biological oxidations provide primarily energy for living processes and the involvement of oxygen in these reactions has been known for a long time. Although a large number of studies has been carried out in regard to the addition and transfer of hydrogen as such in dehydrogenases, it is only in recent years that the importance of reactions concerning direct addition of molecular oxygen has been appreciated and extensive investigations carried out. The enzymes, which catalyse such reactions, have been termed "oxygenases" by Hayaishi and the book under review deals in a very comprehensive manner the latest developments in this field. The activation of molecular oxygen in biological systems is carried out by a few reaction types such as oxidation, hydroxylation and the reduction to water; and several important metabolites and hormones like steroidal hormones, adrenaline, serotonin are produced by some of these reactions.

The subject of oxygenases has been considered in twelve chapters starting with history and scope and going on to methodology of oxygen

isotopes, phenolytic oxygenases, aromatic hydroxylation, oxygenases in lipid and steroid metabolism, bacterial oxidation of hydrocarbons, peroxidase as an oxygenase, phenolase, model oxygenases and theoretical considerations on the activation of oxygen, cytochrome oxidase, haemoglobin and myoglobin and haemoerythrin and haemocyanin. A number of biochemists with expert knowledge of the subject have written one or more of the above articles. Being the first to cover this field of oxygenases in such a detailed manner, the reviewer feels that this book will be well received particularly by those who are primarily concerned in research work on biological oxidations. Though the mechanism of primary reaction of activation of oxygen is still in the realm of speculation, it is hoped that this publication will catalyse greater interest in this extremely fascinating field of enzyme chemistry among a large number of research workers.

P. S. SARMA.

**The Enzymes, Vol. 6.** Edited by P. D. Boyer, H. Lardy and K. Myrback. (Academic Press, New York and London), 1962. Pp. xx + 684. Price 143 sh.

The literature on enzymes and enzyme action has become so voluminous that a comprehensive treatise on this subject is invaluable to research workers. The previous four-volume edition on "The Enzymes" edited by Sumner and Myrback has now been completely revised and considerably enlarged and the second edition is being published in eight volumes. Volume 6 deals with group transfer and syntheses coupled to ATP cleavage. There are four survey articles which deal with general principles applying to each category of enzymes and also with enzymes which are not dealt with separately in special chapters. The other 27 chapters in this volume deal with individual enzymes or groups of enzymes. There are eleven chapters on kinases (transphosphorylases) and two on mutases. The chapters on transfer of amino, amidine, carbamyl, acyl and sulfate groups and transglycosylases offer a comprehensive survey of other group transfer reactions. Acyl and amino-acid activation, luciferase and synthesis of carbamyl groups, glutamine, sulfuryl adenyate and succinyl CoA are among the reactions coupled to ATP cleavage which are dealt with in the remaining chapters.

The high standard of the previous series has been maintained in this volume and the treatment on the whole is critical and comprehensive. There is, of course, considerable variation in the

presentation by the different authors and some chapters are more detailed than others. The last chapter on ATP creatine transphosphorylase is in particular so extensive and detailed as to constitute a small monograph on the enzyme. This chapter includes analyses of data bearing on the enzyme which have been obtained with computers. It appears from this trend and from the rapid progress in the field of enzymes that the third edition of *The Enzymes* will consist of sixteen volumes!

The volumes of this series are so expensive that few can afford to buy them in this country, but they offer the most comprehensive study on enzymes available in English and are indispensable to active workers in this field and should find a place in all technical libraries.

V. J.

---

**Role of Blue-Green Algae in Nitrogen Economy of Indian Agriculture.** By R. N. Singh. (I.C.A.R. Monographs on Algæ), June 1961. Pp. 175. Price Rs. 20-00.

The book is divided into ten chapters: Introduction. General characteristics of the blue-green algæ. Terrestrial and other blue-green algæ. Methods of investigation of soil algæ and their nitrogen-fixing capacity. Nitrogen fixation. Nitrogen fixation in rice fields. Reclamation of Usar lands. Conservation of other soils. Biological productivity of inland waters with special reference to water blooms and the role of blue-green algæ in natural economy. The book embodies a large amount of original data which Dr. Singh has gathered in the past two decades in addition to giving an exhaustive picture of the problem of nitrogen fixation.

Frank (1889) was the first to show that the blue-green algæ are connected with fixation of nitrogen. Drewes (1928) and De and Fritsch were the first in modern times to show that these algæ undoubtedly fix nitrogen. With these two publications a new era of study on nitrogen fixation may be said to have begun. De after his return to India has published a number of papers on this aspect. Recent contributions by Burris et al. (1942 and 1949) using  $N^{15}$  have conclusively proved this capacity of the blue-green algæ to fix elementary nitrogen. Fogg, among many others, has studied intensively this problem and the path of nitrogen fixation. Dr. Singh has studied the blue-green algæ (after Fogg and Wolfe, 1954) which are known to fix nitrogen.

Dr. Singh has for many years studied this problem in this country from a different angle, viz., nitrogen fixation by the algæ of the paddy

field and their contribution to fertility of those paddy fields. Dr. Singh has followed up this pioneering work with a study of a possible utilization of these nitrogen-fixing algæ, in the reclamation of 'Usar' lands. His is a novel suggestion in tackling this most important problem in the land economy of India. Another aspect of this overall problem is the utilization of water blooms, temporary or permanent, that are so common in Indian waters. This again is a problem which Dr. Singh has been studying for a number of years. However, as Dr. Burris has rightly pointed out, the capabilities of algæ as nitrogen fixers never have attracted the detailed investigations afforded by the *Azotobacter*, *Clostridia*, and *Rhizobia* in association with leguminous plants. As Dr. Singh has reviewed this entire problem at great depth and as he himself says this has at places led him into statements which may eventually need to be modified by further work and this book would have eminently served its purpose if it becomes the forerunner of many such publications based on future investigations on this problem in India. The subject of role of blue-green algæ in the economy of the soil holds immense possibilities for study in India.

T. V. DESIKACHARY.

---

**Vaucheriaceae.** By G. S. Venkataraman. (Indian Council of Agricultural Research, New Delhi), 1961. Pp. ix + 112. Figs. 72. Price Rs. 19-00.

This is the fourth in the series of Monographs on Algæ and covers the genera *Vaucheria*, *Vaucheriopsis*, *Dichotomosiphon* and *Pseudodichotomosiphon*. In all the author describes 54 species of *Vaucheria*, 2 of *Vaucheriopsis* and one each of the last two genera. The Introductory portion deals with the Occurrence and Distribution of these genera, Structure of the Thallus and Reproduction. The book is well illustrated and would be very useful for identifying the different species.

From India only the following species belonging to two genera are reported: (1) *Dichotomosiphon tuberosus*; (2) *Vaucheria thuretii*; (3) *V. mayyanadensis*; (4) *V. aversa*; (5) *V. ornithocephala*; (6) *V. ornithocephala* var. *polysperma*; (7) *V. sessilis*; (8) *V. terrestris*; (9) *V. hamata*; (10) *V. amphibia*; (11) *V. walzi*; (12) *V. geminata*; (13) *V. piloboloides*. Most of these have been from northern parts of the country or Bombay State. Very little is known of the genera from the southern parts of India. The availability of a book in English would no doubt make it possible for many more reports of

these genera and species emanating from the still unexplored regions of India. Thus the book is a welcome addition to the series of books intended for the research workers of India.

There is one aspect of the treatment which may be open to some objection. The author places *Vaucheriaceae* in the *Chlorophyceae*. Modern taxonomic practice is to transfer the family *Vaucheriaceae* with *Vaucheria*, *Vaucheriopsis* (?) and *Asterosiphon* to the *Xanthophyceae* and the rest of the genera are left in a new family, the *Dichotomosiphonaceae* in the *Siphonales* of the *Chlorophyceae* (*Chlorophyta*). This procedure has been based on evidences derived from almost all conceivable angles. All recent algologists have followed this procedure. The only exception was the late Prof. Fritsch. Fritsch has, in 1954, advocated caution in this transfer and has cited the case of *Botryococcus* as an anomaly in *Xanthophyceae* similar to *Vaucheria* in *Chlorophyceae*. Since then it has been clearly shown that *Botryococcus* is a green alga having both chlorophyll *a* and *b* and that *Vaucheria* is a *Xanthophyceae*. Later British investigators have also adopted this procedure, and have in fact contributed substantial evidence for this step. Smith, in 1950, accepted the transfer of the *Vaucheriaceae* based on earlier investigations.

T. V. DESIKACHARY.

**Insect Parasites of Live-Stock and Their Control.** By R. P. Chaudhuri. (Indian Council of Agricultural Research, New Delhi), 1962. Pp. 43. Price Rs. 1-30.

The Indian Council of Agricultural Research has published this useful manual. Habits and practicable methods of control are given of about two dozen of the more important insects, ticks and mites which are injurious to domestic animals such as horse, cow, camel, dog, poultry, etc. The injury is caused in two principal ways, namely, some enemies feed on blood and tissues and damage the hides and skin of the hosts, others while feeding introduce disease-causing organisms and thus spread diseases among them. Though the enemies enumerated and their biology and methods of control are well known the information was scattered in numerous journals; therefore practical stock breeders will welcome this manual in which the information is compiled in simple language. It would be useful if the ICAR would publish manuals

similar in scope about the various agricultural commodities also.

From technical point of view, however, the use of some terms and names of some insects is not correct. No distinction seems to have been made between gamma BHC and technical BHC. The very word "parasites" in the title of the Manual is not appropriate.

The printing and general get-up of the publication is unfortunately not as satisfactory as many of the other ICAR publications.

H. S. P.

### Books Received

*Carnegie Institution of Washington—Year Book 61.* (July 1961 to June 1962), (Carnegie Institution of Washington, 1530 P Street, North West, Washington 5 D.C.), 1962. Pp. xi + 526 + 112. Price \$ 1.50.

*Cultivated Plants and Their Wild Relatives.* By P. M. Zukovskij. (Commonwealth Agricultural Bureaux, Farnham House, Bucks), 1962. Pp. 107. Price \$ 1.50.

*Indian Livestock*, (Vol. 1, January 1963, No. 1). (Indian Council of Agricultural Research, New Delhi), 1963. Pp. 64. Price: Annual Subscription Rs. 4-00.

*Men Who Changed the World.* By Egon Larsen. (The English Language Book Society, Phoenix House Ltd., London; India: Macmillan and Co., Madras-2), 1962. Pp. 232. Price 4 sh. 6 d.

*Fields and Circuits in Electrical Machines.* By N. Kesavamurthy and R. E. Bedford. (Thacker Spink and Co. P. Ltd., Calcutta), 1963. Pp. 384. Price Rs. 20-50.

*Electromagnetic Waves in Stratified Media.* By J. R. Wait. (Pergamon Press, Headington Hill Hall, Oxford), 1963. Pp. viii + 372. Price £ 5.00.

*Soil and Freshwater Nematodes.* By T. Goodey. (Revised by J. B. Goodey). (Methuen and Co. Ltd., 36 Essex Street, Strand, London, W.C. 2), 1963. Pp. xvi + 544. Price £ 5.00.

*Biochemical Society Symposia No. 22—The Structure and Function of the Membranes and Surfaces of Cells.* Edited by D. J. Bell and J. K. Grant. (Cambridge University Press, London, N.W. 1), 1963. Pp. 172. Price Cloth 35 sh; Paper 25 sh; No. 23—*Method of Separation of Subcellular Structural Components.* (Cambridge University Press, London, N.W. 1), Pp. 157. Price 35 sh; 25 sh.

## SCIENCE NOTES AND NEWS

### Award of Research Degree

Andhra University has awarded the D.Sc. degree in Physics to Shri A. Narasimhamurthy for his thesis entitled "Theoretical and Experimental Studies on the Electron Paramagnetic Resonance of Certain Single Crystals"; the D.Sc. degree in Technology to Messrs. K. Subba Raju and B. V. Subba Rao for their theses entitled "Heat Transfer and Critical Mass Velocities in Liquid Fluidized Beds" and "Isobaric Vapour Liquid Equilibrium Studies of Binary and Ternary Systems and Mass Transfer Studies in Spray Extraction Tower" respectively; the Ph.D. degree in Geology to Shri R. Vaidyanathan for his thesis entitled "Geomorphological Studies in the South-Western Part of the Cuddapah Basin"; and the Ph.D. degree in Geophysics to Shri I. Subbaramayya for his thesis entitled "Studies on the Indian South-West Monsoon".

The University of Kerala has awarded the Ph.D. degree in Physics to Shri G. Lakshmana Pai of the Physical Research Laboratory, Ahmedabad, for his thesis entitled "The Study of Time Variation of Cosmic Rays at the Geomagnetic Equator".

The M.S. University of Baroda has awarded the Ph.D. degree in Biochemistry to Messrs. Prem Nath Raina and Vinodchandra Kasturchand Shah for their theses entitled "Comparative Metabolic Studies on Normal and Neoplastic Rat Liver" and "Studies on Mold Metabolism" respectively.

Osmania University has awarded the Ph.D. degree in Chemistry to Shri G. Thyagarajan for his thesis entitled "Synthesis of Some N-Substituted 1, 2, 3, 4-Tetrahydroquinolines as Potential CNS Depressants"; and the Ph.D. degree in Geology to Shri G. Shankar Narayana for his thesis entitled "Physical Properties of Limestones".

The Utkal University has awarded the Ph.D. degree in Chemistry to Shri Balakrishna Sabata for his thesis entitled "Studies on Natural Products and Photographic Sensitisers".

### Operational Research Society of India

The Operational Research Society, U.K., is organising a symposium on operational research and the social sciences from 14th to 18th September, 1964. Those who are interested in this

subject and wish to contribute may please contact the Secretary, Operational Research Society of India, c/o Council of Scientific and Industrial Research, Rafi Marg, New Delhi.

### History of Science Unit, C.S.I.R.

The Council of Scientific and Industrial Research, New Delhi, has established a History of Science Unit to carry out primarily studies on the historical development of science in India. The Unit is charged with compiling a comprehensive bibliography of scientific manuscripts available in various Indian languages in different periods of Indian history, prepare subject and period histories of different branches of science, and a comprehensive history of the development of science and technology in this country. It will also work on the social implications of science and the impact of science on modern Indian society.

### The Zoological Society

The Seventeenth Annual General Meeting of the Zoological Society, Calcutta, was held on 31st March 1963, when the report for the year 1962-63 was presented, and office-bearers for the year 1963-64 were elected.

Prof. J. L. Bhaduri and Dr. S. P. Sarkar were re-elected as President and General Secretary respectively.

### Institution of Chemists (India): Associateship Examination 1964

The Fourteenth Associateship Examination of the Institution of Chemists (India) will be held in November, 1964. The last date for Registration is 30th November, 1963. The Examination in Group A (Analytical Chemistry) is divided into the following eleven Sections and each candidate will be examined in two of them according to his choice as approved by the Council, in addition to the General Chemistry including Organic, Inorganic, Physical and Applied-Analytical Chemistry: (1) Analysis of Minerals, Silicates, Ores and Alloys; (2) Analysis of Drugs and Pharmaceuticals; (3) Analysis of Foods; (4) Analysis of Water and Sewage; (5) Biochemical Analysis; (6) Analysis of Oils, Fats and Soaps; (7) Fuel and Gas Analysis; (8) Analysis of Soils and Fertilisers; (9) Analysis connected with Forensic Chemistry;

(10) Analysis connected with Leather Chemistry, and (11) Analysis connected with Textile Chemistry. The Examination is recognised by the Government of India as equivalent to M.Sc. in Chemistry for purposes of recruitment of Chemists.

Further enquiries regarding this and for ordinary Membership may be made to the Honorary Secretary, Institution of Chemists (India), Chemical Department, Medical College, Calcutta-12.

Record of *Habenaria viridiflora* (Sw.) R. Br. var. *dalzellii* Hook. f. from Assam—A Correction

Shri D. B. Deb, Systematic Botanist, Botanical Survey of India, Eastern Circle, Shillong, writes: In the October issue of *Curr. Sci.*, 31 (10): 442, 1962, Shri S. K. Katakai claimed the record for the first time of *Habenaria viridiflora* (Sw.) R. Br. var. *dalzellii* Hook. f. for Eastern India from Maumloo and Imsaw of Khasi and Jaintia Hills, Assam.

Scrutiny of the specimens cited by the author revealed that the said record is based on misidentification. All those specimens are determined as *Habenaria khasiana* Hook. f.

*Odontotermes obesus* Ramb. as a Pest of Japanese Mint

Messrs. Rajendra Gupta and M. K. Agarwal, Central Indian Medicinal Plants Organisation, Sub-Zonal Centre, Jammu, write:

The termite *Odontotermes obesus* Ramb. was observed to cause heavy damages to the standing, live plantations of *Mentha arvensis* Linn. Sub. sp. *Haplocaly* Briquet var. *piparescens* Holmes, the common Japanese Mint cultivated for commercial production of Mint oil and Menthol. The attack results in the loss of approximately 50-60% of the infested fields. Roots are attacked first and the termite, then, may or may not go up to the very tip of the stem from which it comes out by boring holes at any point, or finds its way back through the hollow that it forms while going up. The epidermal and hypodermal portions are not eaten up but get dried to keep the plant standing. The present, as far as we know, is the first record of the termite species attacking Japanese Mint.

#### Volcanicity and Gravity Anomaly

According to Vening Meinesz's analysis of gravity survey there are two areas of large extent on the earth where a systematic excess

of gravity is found. One is the Indonesian Archipelago area of about 6 megameter,<sup>2</sup> and the other the Azores area of about 1 Mm.<sup>2</sup> In both these areas the mean gravity anomaly found is about 30 m.gal. Both anomalies are isostatic anomalies obtained after making the necessary Airy-Heiskanen correction for crust thickness of 30 km. A mean anomaly of 30 m.gal corresponds to an elevation of the geoid above the reference ellipsoid of 40 m. and 20 m. respectively in the two areas mentioned.

The principal geophysical (crustal) phenomena occurring in both Archipelagos are quite different. The Indonesian Archipelago is subject to a strong crustal deformation caused by a large uniaxial compressional stressfield brought about by a horizontal mantle current. The Azores, on the other hand, are situated in the Mid-Atlantic rise below which there is a rising mantle current which causes tension in the crust.

Both areas, however, have one particular feature in common, namely, that they are strongly volcanic. Hence it is reasonable to look for an explanation of the observed gravity anomaly to the effects of this volcanic action. We can well understand that the rising volcanic matter causes in the interior an upward matter-movement leading to gravity excess. On the surface this effect shows itself by the formation of high volcanos. We may, no doubt, expect that in the course of time the whole area will adjust itself to isostatic equilibrium, but this is a slow process and cannot be attained before the volcanic activity is practically extinguished.

We may therefore state that the gravity excesses in these two areas are probably examples of a more general phenomenon which is likely to be present in all areas showing marked volcanic activity where we may expect the geoid to be elevated above the reference-surface.—(*Proc. Roy. Neth. Acad. Sci.*, 1963, 66, 1.)

#### The Ionospheric Top-Side Sounder

Most of our present knowledge of the ionosphere, the ionized upper atmosphere of the earth, has been obtained by study of the radio waves sent from the ground and reflected from the ionosphere layer. By this method only the bottom portion of the ionosphere becomes amenable for study, since the waves which penetrate deep into the ionization layer are not reflected but continue outward into space. With the advent of artificial satellites the possibility of studying the top-side of the

ionosphere by sounding techniques conducted from above has been engaging the attention of ionospheric research groups.

The first top-side sounder to operate in orbit was launched on September 29, 1962, as part of the *Alouette* satellite, 1962  $\beta^a 1$ . The top-side ionosonde consisted of a transmitter, receiver, timing circuits, antennae, and antenna matching networks. The power radiated during a pulse is of the order of 10 W. Two orthogonal antennae are used, a 150-ft. dipole operating at frequencies below 4.5 Mc./s. and a 75 ft. dipole for the range 4.5–11.5 Mc./s. The sounder is operated on command. Once started, it functions for 10 min. generating thirty transmissions in which the radio frequency changes linearly with time over the frequency band 0.4–11.5 Mc./s. It then shuts off automatically until commanded on again. Ni-Cd batteries, recharged by solar cells, permit about 5 hours of operation per day.

The satellite sounder emits pulses of radio waves which travel to a reflecting surface in the ionosphere and back to the receiver in the satellite. The depth of penetration of the waves into the ionosphere and the travel time required for the return trip of the pulse is a function of the radio frequency of the wave. The travel time is expressed in terms of an apparent height of the reflecting surface computed using the velocity of the pulse in free space. Recordings of the apparent height as a function of frequency are generated from information telemetered to the ground. This information consists of the frequency calibration of the modulation of the transmitter, and of the amplitude and time delay of the received pulses.

These recordings, namely, apparent height vs. frequency, constitute the top-side ionograms whose interpretation supplies valuable information about the top-side of the ionosphere inaccessible for ground experiments.

The *Alouette* Satellite, containing the ionosonde for sounding the ionosphere from above, was put into orbit by the U.S. National Aeronautics and Space Administration, and the three institutions which co-operated in this project, viz., the Canadian Defence Research Telecommunications Establishment, the U.K. Radio Research Station and the U.S. Central Radio Propagation Laboratory, have presented some of the early results obtained in this study

in three articles in *Nature*.—(*Nature*, 1963, 197, 636–47.)

#### Lunik-IV—USSR Rocket to Moon

On April 2, 1963, the USSR launched a space rocket towards the Moon. An automatic station weighing 1,422 Kg. installed in the space rocket was expected to reach the area of the Moon in 3½ days. Radio contact with Lunik-IV was maintained by observing stations and initial telemetric information received from aboard the station showed that the instruments were functioning normally.

It will be recalled that there were three previous "Moon shots" by the Soviet Union. The first Moon rocket launched on January 2, 1959, made its closest approach of 5–6000 km. to the Moon, and, deviating from its trajectory, became a satellite of the Sun. The second Lunik launched on September 12, 1959, hit the Moon. Lunik-III launched on October 4, 1959, was successful in photographing the other side of the Moon and telemetering the information to the Earth.

#### Physical Properties of Heavy Oxygen Water

The physical properties of substances composed of pure isotopic molecules are of interest not only as important constants of new materials but also as supplying additional information for the elucidation of the structure of the liquid and solid states. While standard data are known for the physical properties of heavy (hydrogen) water or deuterated water  $D_2O$ , no studies of the physical properties of highly enriched heavy oxygen species of water have been reported so far.

Investigations on the physical properties of  $H_2O^{18}$  and  $D_2O^{18}$  have been undertaken by Steckel and Szapiro of the Weizmann Institute of Science, Israel, and the first communication reports on the density, thermal expansion and melting points of these isotopic species of water.

Density:  $H_2O^{18}$ ,  $d_{40} = 1.107845$ ,  $D_2O^{18}$ ,  $d_{40} = 1.21393$ ; Melting point:  $H_2O^{18}$ ,  $t_{mp} = 0.28^\circ C$ ,  $D_2O^{18}$ ,  $t_{mp} = 4.02^\circ C$ ; The thermal expansions measured from melting point to  $80^\circ C$ . gave the maximum density for  $H_2O^{18}$  as  $1.11255 g./ml.$  at temp.  $4.30^\circ C$ .; and for  $D_2O^{18}$  as  $1.21691$  at temp.  $11.46^\circ C$ .—(*Trans. Farad. Soc.*, 1963, 59, 331.)

245–63. Printed at The Bangalore Press, Bangalore City, by T. K. Balakrishnan, Superintendent, and Published by S. R. S. Sastry, for the Current Science Association, Bangalore.

All material intended for publication and books for review should be addressed to the Editor, *Current Science*, Raman Research Institute, Bangalore-6.

Business correspondence, remittances, subscriptions, advertisements, exchange journals, etc., should be addressed to the Manager, Current Science Association, Bangalore-6.

Subscription Rates: India: Rs. 12–00. Foreign: Rs. 16–00; £ 1–4–0; \$ 4.00.



# PHOTODYNAMICALLY ACTIVE PLANT PRODUCTS

T. R. SESHADRI AND M. S. SOOD

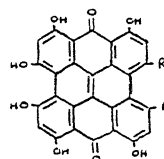
Department of Chemistry, University of Delhi, Delhi-6

## PHOTODYNAMIC COMPOUNDS

### (a) ANTHRONE GROUP

AT the beginning of this century a study by von Tappeiner<sup>1</sup> led to the discovery which is known as "photodynamic effect". According to him, not only micro-organisms but even higher animals could be made sensitive to light by means of fluorescent colouring matters. For example, when eosin is fed to animals such as white rats or rabbits, and they are then exposed to light, they become excited; their skin reddens and oedema sets in. Even after illumination has been stopped, inflammation of the skin develops. These observations explained certain phenomena which went under the names 'hypericisim' and 'fagopyrism' and were known for a long time. These terms have been used for the effects produced on animals when they ate plants of the genera *Hypericum* (St. John's Wort) and *Fagopyrum* (Buck-wheat). The phenomena were very similar to the photodynamic effect and were obviously due to some fluorescent chemicals in the plants. A detailed study by Brockmann and his coworkers<sup>2</sup> over a long period led to the isolation and elucidation of the constitution of the concerned photodynamic pigments. *Hypericum* plants contain hypericin (I) as the main component, along with pseudohypericin (II). These are remarkably large molecules containing condensed benzene rings and are derived from widely distributed anthraquinone derivatives such as emodin (III) by simple reactions taking place in the plants. Fagopyrin (IV), another related compound, was isolated from buck-wheat. The main result of their work is that these photodynamically active plant pigments are derivatives of hexahydroxy helianthrone (V) containing other substituents. They are synthesized in the plants by dehydrogenation of the corresponding substituted dianthrone (VI). These dianthrone seem to be fairly widely occurring. Actually di-emodin anthrone (VI) is found as its diglycoside in *Frangula* bark and di-rhein anthrone glycosides (sennosides) are present in *senna* leaves. These are well-known plant purgatives.

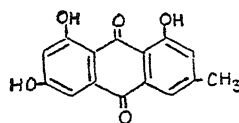
Hypericin (I) has been synthesised by Brockmann<sup>2</sup> from trimethyl ether of 1-bromo emodin (VII), which was earlier prepared by



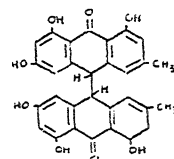
(I), R = -CH<sub>3</sub>

(II), R = -CH<sub>2</sub>-CH<sub>2</sub>-OH

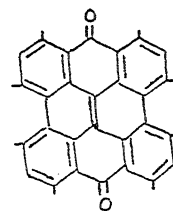
(IV), R = -CH<sub>2</sub>-(C<sub>6</sub>H<sub>4</sub>OH)



(III)

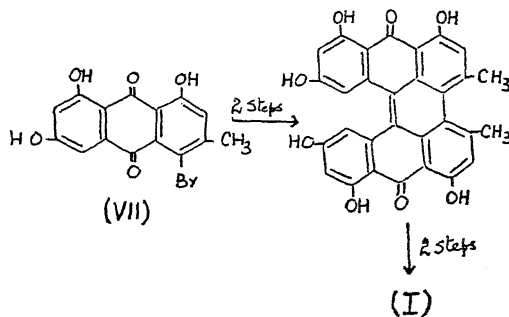


(VI)



(V)

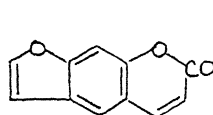
Adams and Jacobsen.<sup>3</sup> It (VII) was converted into hypericin as shown below.



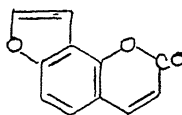
### (b) Psoralen Group

There is another group of compounds which do not seem to produce such marked ill-effects but are still found to be photodynamically active and have been used for the treatment of certain skin diseases. For a long time plants containing furanocoumarins have been used in different parts of the world for the treatment of vitiligo, commonly known as leucoderma. The most important plant materials which have been frequently used in the form of their preparations are the seeds of *Psoralea corylifolia*, *Ammi visnaga*, *Ammi majus* and *Pongamia glabra*.

*Psoralea corylifolia*, the most important species of the genus *Psoralea*, belongs to the family *Leguminosae*. The seeds of this plant have been in use in Indian medicine from ancient times and according to some physicians they are useful in the treatment of diseases of the skin such as leucoderma and psoriasis. The drug is prescribed both for local application and for oral administration. It was as early as 1923 when a careful examination of the seeds was made in the Calcutta School of Tropical Medicine and an oleo-resin fraction was prepared for clinical trials. The results of its local application on leucodermic spots were satisfactory, and created considerable amount of interest in the further study of the drug. The active constituents, psoralen (VIII) and isopsoralen (IX), were isolated in a crystalline condition by Jois *et al.*<sup>4</sup>; later, Rangaswami and Seshadri<sup>5</sup> gave a convenient method for the isolation of the mixture of psoralen and isopsoralen. Recently, Khastgir *et al.*<sup>6</sup> further improved this method. This mixture has been used successfully in the treatment of leucoderma.<sup>7</sup> It is administered orally and applied locally at the leucodermic spots, which are then exposed to sunlight or U.V. light.



(VIII)

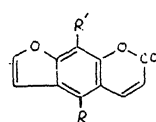
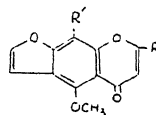


(IX)

Another important drug which has been given a prominent position in the treatment of leucoderma is the seeds of *Ammi visnaga* L. Extracts of this plant, under the name khellah or chellah, have been used for centuries as a home remedy to relieve spasms of all kinds and also as a cure for leucoderma.<sup>8</sup> The earliest work in the direction of chemical investigation of this drug was done by Späth and Grüber.<sup>9</sup> They obtained kellin (X) as the major product of the ether extract of the seeds of the plant, along with visnagin (XI) and kellol glycoside (XII). These are  $\gamma$ -pyrone derivatives. Later fractions of the ether extract of the drug which are more active, contain coumarin derivatives.

It was later discovered that the fruits of *Ammi majus*, a closely related plant, are far more useful for leucoderma whereas *Ammi visnaga*, and particularly kellin, have been useful for the treatment of heart diseases. *Ammi majus* was originally grown in Egypt. It is also grown in India as an ornamental plant in gardens. The efficacy of its seeds in the

treatment of leucoderma was first observed in 1946 in Egypt and later in France. Its active constituents were tested either in the form of tablets or as extracts and encouraging results were reported. Further, the isolation of the active principles and their identification as xanthotoxin (XIII), imperatorin (XIV) and bergapten (XV) by Falmy and Abushady<sup>10</sup> and by Schönberg and Sina<sup>11</sup> opened a new line of investigation on the therapeutic efficacy of these coumarin compounds in the cure of leucoderma. Several other plants contain these photodynamically active compounds. Among these are *Ficus carica*, *Angelica officinalis*, *Pastinaca sativa*, *Luvanga scandens*, *Aegle marmelos*, *Heracleum mantegazianum* and *Ruta graveolens*.



(X),  $R = -CH_3$ ;  $R' = -OCH_3$ . (XIII),  $R = H$ ;  $R' = -OCH_3$

(XI),  $R = -CH_3$ ;  $R' = H$ .

(XIV),  $R = H$ ;  $R' = -OCH_2CH_3$

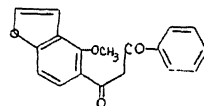
(XII),  $R = -CH_2OGL$ ;  $R' = H$ .

(XV),  $R = -OCH_3$ ;  $R' = H$

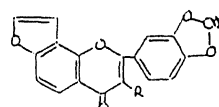
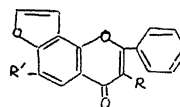
(XXI),  $R = -OCH_2CH_2C(CH_3)_2$   
 $R' = H$

### (c) Flavone Group

*Pongamia glabra*, the important Indian species of the genus *Pongamia*, belongs to the family *Leguminosae*. The oil of the seeds, commonly known as karanj oil, has been well known as an efficient home remedy for the treatment of common ailments and skin diseases like leucoderma.<sup>12</sup> Chemical examination of the seed oil (from *Pongamia glabra*) was first reported by Limaye,<sup>13</sup> who isolated a bitter crystalline furanoflavone and named it karanjin (XVI). It exerts appreciable curative



(XVII)



(XVI),  $R = -OCH_3$ ;  $R' = H$

(XXI),  $R = -OCH_3$

(XVII),  $R = H$ ;  $R' = -OCH_3$

(XX),  $R = H$

effect in skin diseases and is free from highly irritating and inflammatory effects of coumarin

compounds. Recently many other compounds have been isolated and their constitutions established.<sup>14,15</sup> These are pongamol (XVII), kanjone (XVIII), pongapin (XIX) and pongaglabrone (XX).

#### CHEMICAL CONSTITUTION AND PHOTODYNAMIC ACTIVITY

Skin photosensitization is at present the best known property of furanocoumarins. Photo-dermatitis occurs when the skin comes in contact with plants or vegetable products and is then exposed to sunlight or U.V. light. Further, erythemas of various degrees, followed by pigmentation, appear after a latent period. As early as 1938, Kuske<sup>16</sup> studied some of these cases and found that, besides plant extracts, two pure coumarins, oxypeucedanin (XXI) and bergapten, were also photodynamically active.

Recently Musajo and Rodighiero<sup>17</sup> have studied the photosensitizing effect of psoralen (VIII) and have tried to establish the relationship between structure and photodynamic property in coumarins. They used the ethanolic solution of these compounds on 2-4 cm.<sup>2</sup> size areas of the human skin and then exposed them to sunlight or U.V. light. They also performed quantitative tests by determining the minimum time of irradiation, necessary to produce erythema on the skin, taking psoralen as a standard. Pathak *et al.*<sup>18</sup> have done experiments on guinea-pigs by applying 1000  $\mu$ g. of each furanocoumarin on the skin, which was irradiated for 45 minutes with a U.V. lamp placed at a distance of 12-15 cm. The results of their investigations led to the following conclusions:

(i) Photodynamic activity is fundamentally linked to the furanocoumarinic ring system and seems to depend upon the position of the furan ring; in fact, linear furanocoumarinic structure (as found in psoralen) is more effective than the angular one (as found in angelicin). (ii) Substitution in the condensed benzene ring reduces the activity. Groups like  $-\text{OCH}_3$ ,  $-\text{CH}_3$ ,  $-\text{COCH}_3$ , etc., decrease the activity, while  $-\text{OH}$ ,  $-\text{NH}_2$ ,  $-\text{NO}_2$ , etc., annul the activity of the parent compounds.

The widespread occurrence of such compounds like bergapten, xanthotoxin, etc., gives an explanation for the frequent occurrence of photo-dermatitis of vegetable origin. It was known quite early that celery and parsley cause dermatitis on the hands of the people who handle them, but the reason was clear only when Musajo and Rodighiero (*loc. cit.*) isolated bergapten from them.

The physiological properties of furanocoumarins have been compared with other photo-

dynamically active compounds like h  matorporphyrin, hypericin and fagopyrin and it was shown that furanocoumarins exhibit a different type of photodynamic activity. For instance, the former group of compounds photo-oxidize  $\alpha$ -terpinene, and blood serum but are not active if painted on the skin. Furanocoumarins, on the contrary, do not influence the photo-oxidation of  $\alpha$ -terpinene and do not oxidize blood serum proteins to an appreciable extent but are active when painted on the skin. Both groups on intradermal injection provoke dermatitis, erythema and later pigmentation. So it is clear that furanocoumarins are a group of photodynamic compounds having a peculiar type of activity and their effect on the skin is not a photo-oxidation of proteic substrates. Recently, Rashid and Aggrawala<sup>19</sup> have shown that psoralen in aqueous ethanolic solution gives degradative products which inactivate  $-\text{SH}$  group as indicated by the inhibition of succinic dehydrogenase of rat kidney and reversal of thiourea inhibition of potato tyrosinase when exposed to solar irradiations. This inactivation has been considered to be related to the role of psoralen in the production of pigments. Previously it was thought that furanocoumarins could probably cause light cancer but recently Pathak *et al.*<sup>18</sup> have found that they are not dangerous in this way.

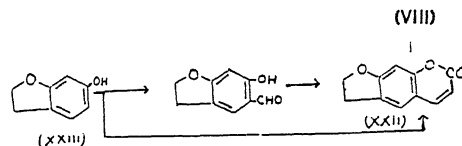
#### SYNTHESIS IN THE FURANOPYRONE GROUP

In view of the interest on the possible pigment stimulating properties of these compounds in the treatment of leucoderma, there was need for a convenient synthesis in order to produce them on a large scale for study and use in the cure of leucoderma.

#### COUMARIN GROUP

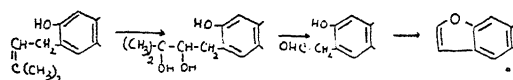
##### (a) Linear Furanocoumarins

Psoralen (VIII) is the most active member of the group and is present in *Psoralea corylifolia* and in several other plant sources. It has earlier been synthesized by four different routes. In the first three syntheses<sup>20-22</sup> dihydropso-ralen (XXII) has been obtained from 6-hydroxy-coumaran (XXIII) by different ways as shown below. The dihydro compound was converted

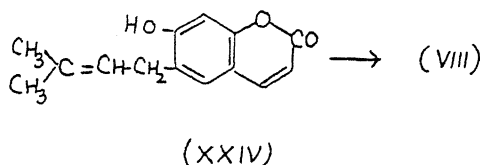


into psoralen in poor yield by treating it with Pd-C catalyst.

Aneja *et al.*<sup>23</sup> made a general study of the origin of the furan ring in natural products and concluded that a prenyl unit underwent oxidation at the double bond, followed by ring closure. They modified this to develop a new and convenient method of furan ring closure. It consists of the Claisen migration of an allyl ether and the subsequent oxidation of the allylic double bond by ozone. The ozonide can be decomposed by catalytic hydrogenation. Raizada *et al.*<sup>24</sup> used osmium tetroxide instead of ozone for the oxidation of allylic double bond. The diol so obtained was degraded with potassium periodate. The acetaldehyde intermediate in both the cases was cyclised by means of polyphosphoric acid. These general features are brought out in the following formulæ.

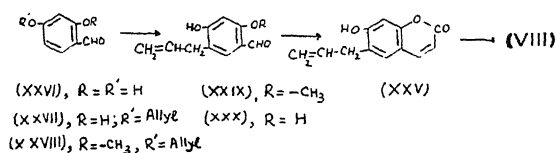


Based on these ideas Aneja *et al.*<sup>23</sup> obtained psoralen starting from demethylsuberosin (XXIV), a naturally occurring coumarin.

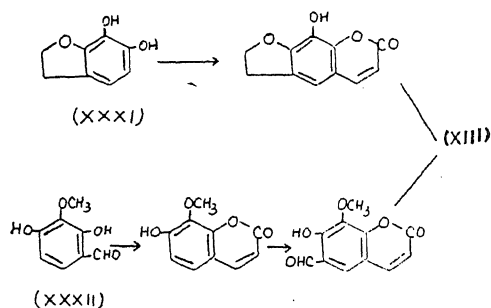


For purely synthetic purposes, a simple allyl group should be equally good. 6-Allyl umbelliferone (XXV) could therefore be the most satisfactory for this purpose. As there is no simple method for the preparation of this compound from umbelliferone, an alternative procedure<sup>25</sup> starting from  $\beta$ -resorcyraldehyde (XXVI) has now been worked out quite satisfactorily. It could be partially allylated<sup>26</sup> to 4-0-allyl- $\beta$ -resorcyraldehyde (XXVII). This, however, could not be used directly for Claisen migration because it has been shown to go into the active 3-position. Therefore, a modified procedure has to be employed in which the ortho-hydroxyl is protected before Claisen migration. Benzyl and tosyl groups were found to be unsatisfactory for this purpose; methyl group was, therefore, used. 4-0-Allyl- $\beta$ -resorcyraldehyde (XXVII) was methylated using dimethyl sulphate and potassium carbonate. The allyl methyl ether (XXVIII) was subjected to Claisen migration when 5-allyl-4-hydroxy-2-methoxybenzaldehyde (XXIX) was obtained. Demethylation using  $\text{AlCl}_3$ -ether gave 5-allyl-

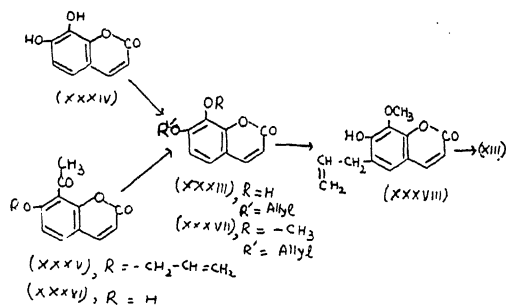
2,4-dihydroxy benzaldehyde (XXX) which on Perkin condensation yielded 7-hydroxy-6-allylcoumarin (XXV). It was subjected to ozonolysis and the intermediate acetaldehyde was cyclised by means of polyphosphoric acid to psoralen (VIII). The yields in all the steps are very good. Instead of ozone, osmium tetroxide-periodate mixture has also been used but the yields have not been very satisfactory.



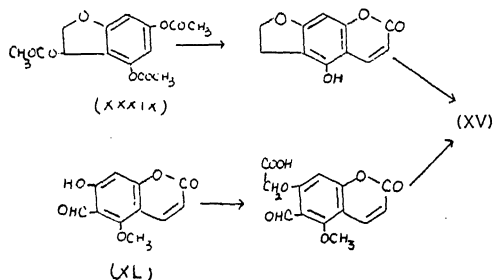
Xanthotoxin (XIII) is the most active component of the fruits of *Ammi majus*.<sup>10,11</sup> It occurs in many other plant sources and was earlier prepared by two different methods. Spath and Pailer<sup>27</sup> carried out the first synthesis, using 6,7-dihydroxycoumaran as the intermediate (XXXI). Rodighiero and Antonello<sup>28</sup> used 2,4-dihydroxy-3-methoxybenzaldehyde (XXXII) and synthesised xanthotoxin by the route as shown below:



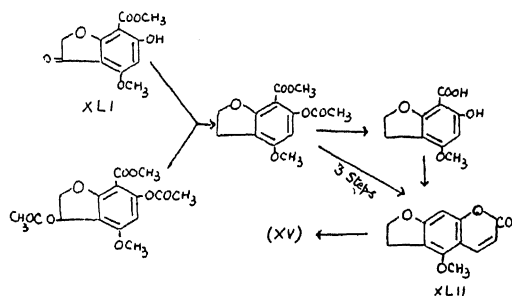
However, the yields were not satisfactory and there was need for a good and convenient synthesis of xanthotoxin. This has recently been achieved and the essential intermediate, 7-allyloxy-8-hydroxycoumarin (XXXIII), has been prepared by the partial allylation of 7,8-dihydroxycoumarin<sup>29</sup> (XXXIV). It has also been prepared by the Dakin's oxidation of 8-acetyl-7-allyloxy coumarin (XXXV), which was obtained by the allylation of 8-acetyl-7-hydroxycoumarin<sup>30</sup> (XXXVI). 7-Allyloxy-8-hydroxycoumarin (XXXIII) was methylated using dimethyl sulphate and potassium carbonate. The methyl allyl ether (XXXVII) so obtained, was subjected to Claisen migration and the 6-allyl compound (XXXVIII) converted to xanthotoxin employing the method as described in the case of psoralen.



Bergapten (XV) is widely distributed in plants. It occurs in bergamot oil and in *Fagara xanthoxyloides* belonging to the family Rutaceae. It was first synthesised by Spath *et al.*<sup>31</sup> starting from 3, 4, 6-triacetoxy coumaran (XXXIX) and condensing it with sodioformyl acetate. The resulting product on methylation gave bergapten. Howell and Robertson<sup>32</sup> made it from 6-formyl-7-hydroxy-5-methoxy coumarin (XL) as shown below:



A more convenient synthesis recorded by Caporale<sup>33</sup> involves the protection of the reactive nuclear position with carbomethoxy group and its subsequent removal. The starting material was methyl-4-methoxy-6-hydroxy coumaran-3-one-7-carboxylate (XLI) which was converted to 4', 5'-dihydro-5-methoxy-2', 3' : 7, 6-furanocoumarin (dihydro bergapten) (XLII) by two different methods as indicated below:



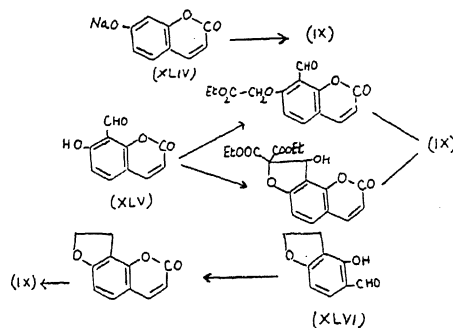
Although this is a good synthesis the number of steps involved and the difficulty in the prepa-

ration of the starting material make it inconvenient and so there is need for a good synthesis of bergapten based on the ozonolysis of the corresponding C-allyl compound.

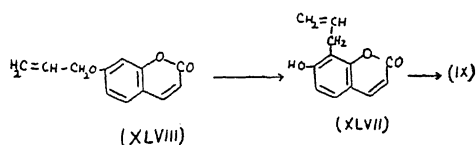
#### (b) Angular Furanocoumarins

Angular furanocoumarins have also been found to exhibit photodynamic property though not to the same extent as exhibited by the linear isomers. These may be useful for milder effects; moreover, these are easily prepared as compared to their linear isomers. Musajo and Rodighiero (*loc. cit.*) have shown that angelicin and isobergapten (XLIII) are  $\frac{1}{4}$  as active as psoralen. Various approaches to their syntheses are given below.

Angelicin (IX) occurs with psoralen, its linear isomer, in the seeds of *Psoralea corylifolia* and in the roots of *Angelica archangelica*. It was first synthesised by Spath and Pailer<sup>34</sup> starting from sodio-umbelliferone (XLIV) and bromoacetal. It has also been prepared from 8-formyl-7-hydroxycoumarin<sup>34</sup> (XLV) as indicated by the route (XLV to IX). Recently, Kawase *et al.*<sup>35</sup> have modified this method using bromomalonate instead of bromoacetic ester. Limaye<sup>36</sup> gave a slightly different route, starting from 5-formyl-4-hydroxycoumaran (XLVI). This method gave poor yields, as the preparation of 4-hydroxycoumaran is difficult.

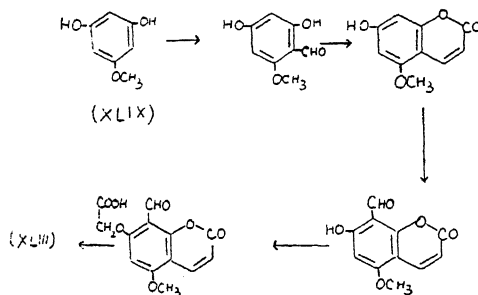


Seshadri and coworkers<sup>23-24</sup> recorded a convenient synthesis of angelicin. 8-Allyl-7-hydroxycoumarin (XLVII), obtained by the Claisen migration of 7-allyloxycoumarin (XLVIII), was subjected to ozonolysis or



osmium tetroxide-periodate oxidation and the intermediate acetaldehyde was cyclised to angelicin in very good yields.

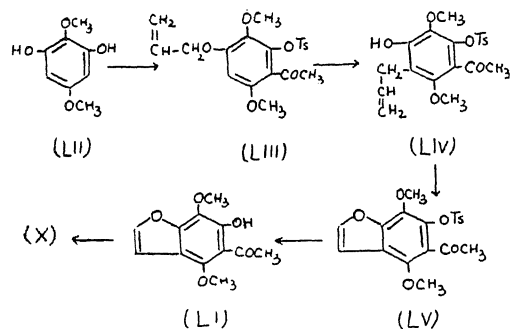
*Isobergaptin* (XLIII) occurs in *Pimpinella saxifraga* and was first synthesised by Rodighiero and Antonello<sup>37</sup> starting from phlorogucinol monomethyl ether (XLIX). The various steps involved in the synthesis are indicated below. Since the reported yields are not satisfactory, there is need for a good and convenient synthesis of isobergaptin based on the ozonolysis of the appropriate C-allyl compound.



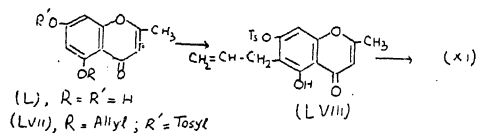
#### CHROMONE DERIVATIVES

For a considerable length of time, the seeds of *Ammi visnaga* were claimed to be efficacious in the treatment of leucoderma and this property was attributed to the presence of two furanochromones, kellin and visnagin. It was later shown that the seeds of *Ammi majus*, a closely related plant containing the furanocoumarins, were the more active drugs. Still the furanochromones and furanoflavones seem to have some, though weak, effect on leucoderma and they are sometimes desirable because of their milder action.

Kellin (X) is the chief active component of seeds of *Ammi visnaga* and has been synthesized by a number of methods. The earliest method<sup>38</sup> consisted in the introduction of a furan ring in 2-methyl-5 : 7-dihydroxychromone (L) but it does not always work satisfactorily. A successful synthesis of kellin was carried out by oxidation of visnagin, which had been obtained from 2-methyl-5 : 7-dihydroxychromone. This is later discussed under visnagin. The direct methods for the synthesis of kellin, using kellinone (LI) as intermediate are definitely better. Kellinone has been made by a number of methods,<sup>39-41</sup> and the most satisfactory is that of Aneja *et al.*<sup>42</sup> 2, 5-Dimethoxyresorcinol (LII) was converted to 2-tosyloxy-3 : 6-dimethoxy-4-allyloxyacetophenone (LIII), which on Claisen migration yielded the C-allylacetophenone (LIV). Ozonolysis followed by cyclodehydration gave 2-O-tosyl kellinone (LV) which, on hydrolysis, yielded kellinone. This was then converted to kellin by employing the diketone method.



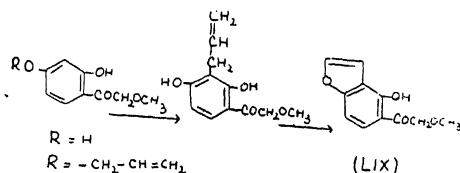
Visnagin (XI) is the second important component of the seeds of *Ammi visnaga* and has been synthesized by a number of methods. The earlier methods<sup>43-45</sup> involved visnaginone as the intermediate but gave poor yields of visnagin because of the possibility of formation of isomeric compounds. Aneja *et al.*<sup>46</sup> developed a synthesis of visnagin, starting from 5 : 7-dihydroxy-2-methyl chromone, which gave an excellent yield. 5-Allyloxy-2-methyl-7-tosyloxychromone (LVII) was prepared from the dihydroxychromone (L) by tosylation, followed by allylation. On Claisen migration it gave 7-tosyloxy-5-hydroxy-6-allyl-2-methylchromone (LVIII), which was converted to visnagin by the ozone-phosphoric acid method.



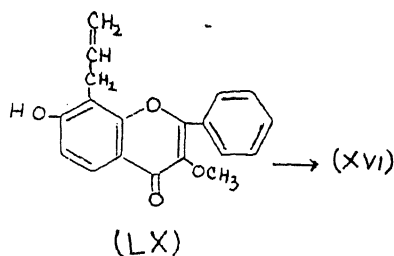
Visnagin can conveniently be converted into kellin. The simplest method<sup>42</sup> consists in demethylating it to norvisnagin followed by persulphate oxidation to nor-kellin and finally methylating to kellin. The yield in this procedure is not good; it is much improved by the preliminary hydrogenation of the furan ring and final dehydrogenation.

#### FLAVONE GROUP

Karanjin (XVI) is the main component of *Pongamia* seeds and oil. Two main lines for the syntheses have been adopted. The first successful method involved the initial preparation of karanj ketone (LIX), as the main intermediate followed by Allan-Robinson flavone condensation. The earlier procedure adopted by Seshadri and Venkateswarlu<sup>47</sup> involved a large number of steps. Considerable simplification has been achieved in the recent method of Aneja *et al.*<sup>51</sup> who used the following main steps for the preparation of this ketone.



The alternative method of building up the furan ring on the flavone unit was first attempted by Rangaswami and Seshadri.<sup>48</sup> There was difficulty at the last decarboxylation stage. Row and Seshadri,<sup>49</sup> however, succeeded in getting a small yield of karanjin. Later Kawase *et al.*<sup>50</sup> obtained a better yield of karanjin by improving the conditions for decarboxylation. This difficulty is completely eliminated and synthesis, simplified by the application of ozonolysis method<sup>51</sup> to 8-allyl-3-methoxy-7-hydroxyflavone (LX), gives good yields of karanjin. Later Raizada *et al.* (*loc. cit.*) used osmium tetroxide-periodate mixture for the oxidation of allylic double bond instead of ozone, but the yields are not good.



1. von Tappeiner, *Ergebn. Physiol.*, 1909, **8**, 698.
2. Brockmann, H., *Proc. Chem. Soc.*, 1957, p. 304.
3. Adams, R. and Jacobsen, R. A., *J. Amer. Chem. Soc.*, 1924, **46**, 1312.
4. Jois, H. S., Manjunath, B. L. and Rao, S. V., *J. Ind. Chem. Soc.*, 1933, **10**, 41.
5. Rangaswami, S. and Seshadri, T. R., *J. Pharm.*, 1943, **5**, 105.
6. Khashtgir, H. N., Dutta Gupta, P. C. and Sen Gupta, P., *Ind. J. Appl. Chem.*, 1959, **22**, 82.
7. Mukerji, B., *J. Sci. Ind. Res.*, 1957, Supplement, p. 1.
8. Mustapha, I., *Compt. rend.*, 1879, **89**, 442; Fautl, P. and Samman, *Quart. J. Pharm. Pharmacol.*, 1931, **4**, 14.
9. Späth, E. and Gruber, W., *Ber.*, 1941, **74**, 1492.
10. Falmy, J. R. and Abushady, H., *Quart. J. Pharm. Pharmacol.*, 1947, **23**, 281; 1948, **21**, 499.
11. Schönberg, A. and Sina, A., *Nature*, 1948, **161**, 481; *J. Amer. chem. Soc.*, 1950, **72**, 4826.
12. Nadkarni, *Indian Meteric. Medica*, p. 703; Rao, Rao and Seshadri, T. R., *Proc. Ind. Acad. Sci.*, 1939, **13 A**, 65.
13. Limaye, D. B., *Abst. Proc. Ind. Congress*, 1925, p. 118; 1926, p. 151.
14. Rangaswami, S. and Seshadri, T. R., *Curr. Sci.*, 1940, **9**, 179; *Proc. Ind. Acad. Sci.*, 1942, **15 A**, 417.
15. Aneja, R., Khanna, R. N. and Seshadri, T. R., *J. Chem. Soc.*, 1963, **1**, 163; Khanna, R. N. and Seshadri, T. R., *Tetrahedron*, 1963, **1**, 219.
16. Kuske, H., *Archiv. Dermatol. Syphil.*, 1938, **178**, 112; *Dermatologica*, 1940, **82**, 273.
17. Musajo, L. and Rodighiero, G., *Experientia*, 1962, **18**, 153.
18. Pathak, M. A., Fellman, J. H. and Kaufman, K. D., *J. Invest. Dermatol.*, 1960, **35**, 165.
19. Raishid Ali and Aggrawala, S. C., *J. Sci. Ind. Res.*, 1962, **21 C**, 321.
20. Späth, E., Manjunath, B. L., Pailer, M. and Jois, H. S., *Ber.*, 1936, **65 B**, 1087.
21. Foster, R. T., Robertson, A. and Bushra, A., *J. Chem. Soc.*, 1948, pp. 2254.
22. Hirning, F. C. and Reisner, D. B., *J. Amer. Chem. Soc.*, 1948, **70**, 3619.
23. Aneja, R., Mukerjee, S. K. and Seshadri, T. R., *Tetrahedron*, 1958, **4**, 256.
24. Raizada, S. K., Sarin, P. S. and Seshadri, T. R., *J. Sci. Ind. Res.*, 1960, **19 B**, 76.
25. Seshadri, T. R. and Sood, M. S., *Indian J. Chem.* (Under publication).
26. Baker, W. and Lothian, O. M., *J. Chem. Soc.* 1936, p. 274.
27. Späth, E. and Pailer, M., *Ber.*, 1936, **69**, 767.
28. Rodighiero, G. and Antonello, C., *Ann. Chem.* 1956, **46**, 960.
29. Seshadri, T. R. and Sood, M. S., *J. Ind. Chem. Soc.*, 1962, p. 539.
30. Limaye, D. B. and Joshi, M. C., *Rasayanam*, 1941, p. 227.
31. Späth, E., Wessely, F. and Kubizek, G., *Ber.*, 1937, **70**, 487.
32. Howell, W. N. and Robertson, A., *J. Chem. Soc.*, 1937, p. 293.
33. Caporale, G., *Farmaco. Ed. Sci.*, 1958, **13**, 784; *Anna Chim.*, 1958, **48**, 650.
34. Späth, E. and Pailer, M., *Ber.*, 1934, **67**, 1212; 1935, **68**, 1940.
35. Kawase, Nakayawa and Tamatsuki, *Bull. Chem. Soc. Japan*, 1962, **35**, 149.
36. Limaye, D. B., *Rasayanam*, 1936, **1**, 1; 1939, **1**, 187.
37. Rodighiero, G. and Antonello, C., *IL Farmaco. Ed. Sci.*, 1955, **10**, 889.
38. Murti, V. V. S. and Seshadri, T. R., *Proc. Ind. Acad. Sci.*, 1949, **30 A**, 107.
39. Clarke, J. R. and Robertson, A., *J. Chem. Soc.*, 1949, p. 302.
40. Baxter, R. A., Ramage, G. R. and Timson, J. A., *Ibid.*, 1949, p. 530.
41. Geissman, T. A. and Halsall, T. G., *J. Amer. Chem. Soc.*, 1951, **73**, 1280.
42. Aneja, R., Mukerjee, S. K. and Seshadri, T. R., *Ber.*, 1960, **93**, 297.
43. Gruber, W. and Horvath, K., *Monatsh*, 1950, **81**, 819.
44. Davies, J. S. M. and Norris, W. L., *J. Chem. Soc.*, 1950, Pp. 3195.
45. Geissman, T. A. and Hinreiner, E., *J. Amer. Chem. Soc.*, 1951, **73**, 782.
46. Aneja, R., Mukerjee, S. K. and Seshadri, T. R., *Tetrahedron*, 1958, **3**, 230.
47. Seshadri, T. R. and Venkateswarlu, V., *Proc. Ind. Acad. Sci.*, 1941, **13 A**, 404; 1943, **17 A**, 16.
48. Rangaswami, S. and Seshadri, T. R., *Ibid.*, 1939, **9 A**, 259.
49. Row, L. R. and Seshadri, T. R., *Ibid.*, 1951, **33 A**, 168.
50. Kawase, Matsumoto and Fukui, *Bull. Chem. Soc., Japan*, 1955, **28**, 273.
51. Aneja, R., Mukerjee, S. K. and Seshadri, T. R., *Tetrahedron*, 1958, **2**, 203.

DIFFERENTIAL CROSSABILITY OF MAIZE STRAINS WITH *TRIPSACUM*

SATISH C. ANAND AND EARL R. LENG

Department of Agronomy, University of Illinois, Urbana, Illinois, U.S.A.

THE report of Mangelsdorf and Reeves<sup>1</sup> in 1931 that maize could be hybridized with species of *Tripsacum* made it apparent that there was a possibility of transferring desired genetic material from the latter genus to maize. Since the *Tripsacum* species are perennials and also appear to carry immunity to some of the major fungal diseases affecting maize,<sup>2</sup> there is ample reason to be interested in determining how such a transfer of germ plasm could best be achieved. Moreover, the possible role of *Tripsacum* in the origin and evolution of cultivated maize strains still is not fully clarified, and it appears that further useful information on this matter could be obtained from additional studies of intergeneric hybrids.

Subsequent to the studies of Mangelsdorf and Reeves, other workers<sup>1,2,5</sup> have reported varying degrees of success with attempts to hybridize maize with *Tripsacum*. Since the results reported were not consistent, we decided to approach the problem by attempting to hybridize a wide variety of maize lines and strains with various collections of *Tripsacum* species. The first set of material tested, with results to be reported in this paper, involved crosses of a "diploid" clone of *Tripsacum dactyloides* ( $2n = 36$  chromosomes) with 42 European maize strains and 82 different inbred lines derived from United States varieties. The European strains included plant introduction stocks from Spain, Portugal, Italy, East Germany, Czechoslovakia, Poland and Hungary, most of which had been propagated one or more generations at the North Central Regional Plant Introduction Station at Ames., Iowa. These European collections, for the most part, represented strains or varieties important in the respective areas from which they were originally obtained. All plants involved in the attempted crosses were field-grown at Urbana, Illinois, during the summer season of 1962.

Hybridization techniques used were basically those of Mangelsdorf and Reeves, with minor modifications. In all cases, maize strains were used as the female parents. The husks were removed from unpollinated ears and the styles (silks) were trimmed to one-inch length. A small amount of maize pollen was placed on the silks at the tip of the ear, since this has been found to help in establishing the vascular system

of the developing cob. The ears were then covered with small plastic bags to prevent drying of the silks. During the morning of the following day, silks on the remaining portion of the ear were pollinated with *Tripsacum* pollen. The pollinated ears were later covered with heavy Kraft paper bags to protect the developing kernels.

Immature hybrid embryos were excised under sterile conditions 12 to 28 days after pollination. The excised embryos were transferred to vials containing White's nutrient medium, supplemented with vitamins. Embryos younger than 18 days (after pollination) failed to grow *in vitro*, although a massive growth of undifferentiated tissue often occurred. Best growth was obtained with embryos 18 to 20 days old, many of which developed into healthy plants. Embryos more than 20 days old usually had ceased to develop normally *in vivo* because of complete deterioration of the endosperm tissue. When plants grown from embryo culture became too large for their vials, they were potted off into sterilized soil and transferred to the greenhouse.

The different lines and strains of maize used as female parents showed markedly differential ability to hybridize with the *Tripsacum* clone which provided the source of pollen. As shown in Table I, the European strains as a group

TABLE I  
Effect of maize strain source on ability to produce hybrid embryos with *Tripsacum*

Maize source	No. lines "or" strains	No. strains producing embryos viable <i>in vitro</i>	Total number viable embryos produced
Europe	46	15	46
U. S.	82	12	27

hybridized much more readily than the United States lines. These findings are of particular interest when compared with those of Randolph,<sup>5</sup> who was able to obtain only a few successful hybrids between *Tripsacum* and Mexican or Guatemalan varieties of maize, or of Farquharson<sup>1</sup> who obtained a successful hybrid only by use of pollen from a primitive Peruvian maize strain. Since most of the European strains used in our study had been grown in Europe for at



least 50, and in some cases as many as 300 years, it is clear that they are not closely related to the United States lines. It could be hypothesized either that the European strains hybridize more freely because they are more primitive and thus perhaps more closely related to *Tripsacum*, or else that modern U.S. maize is less *Tripsacum* compatible because it is more strongly introgressed with "Tripsacoid" germ plasm than are the European types. From our studies, we have thus far derived no evidence to support or refute either hypothesis. In any case, the results demonstrate that substantial numbers

of viable hybrid embryos can readily be obtained by crossing certain European maize strains with *Tripsacum* and by culturing the hybrid embryos after 18 to 20 days of development.

1. Engelman, Lois L., *Jour. Hered.*, 1957, **48**, 295.
2. Galinat, W. C., *Maize Gen. C. of. News Letter*, 1961, **35**, 38.
3. Mahn, N. R. and Beckett, J. B., *Crop Science*, 1962, **2**, 360.
4. Mangeloroff, P. C. and Reeves, R. G., *Jour. Hered.*, 1931, **22**, 320.
5. Randolph, I. F., *Am. Nat.*, 1952, **86**, 193.

## AIR POLLUTION\*

SINCE the Industrial Revolution there has been an ever-increasing urbanization to meet the expensive demand of industry. As a consequence, the disposal of sewage and industrial waste early posed the problem of preventing the pollution of surface and underground waters. To ameliorate this situation a great deal has been done through adequate check, control, and laws. However, the accelerated pace of industrialization has phenomenally increased the consumption of coal, petroleum products, minerals and chemicals. As a result, there is a vast discharge of impurities which contaminate the air. Let us, therefore, review the phenomenon of air pollution and the implications of the pollutants.

Such air borne substances as produce a measurable reaction in materials, vegetation, animal and man, are considered pollutants. They may occur in the form of gases, liquid droplets or solid particles. They may originate from identifiable sources, emerge from interactions among pollutants, or be a product of a reaction of a pollutant with normal atmospheric constituents, with or without photoactivation. As a result the polluting entities, entering the atmosphere, rarely retain their original identity. This catalytic action facilitated by gaseous, liquid and solid surfaces, and further accentuated by thermal and photochemical reactions, provides a varying, complex and dynamic character to the polluted air mass, both in space and time. The chain of reactions and resulting emissions and their end-effect, because of inadequacy of investigations and knowledge,

cannot be predicted with certainty. However, the available data make it possible to define primary reactants, identify troublesome reaction chains, and enable retroactive abatement to primary species contributing to the chain. Such is the complex character of the birth, growth and dispersion of air pollutants.

The two volumes under review are edited by Arthur C. Stern of the United States Public Health Service. They are an encyclopedic synthesis of available scholarship, both in reading and treatment. A team of forty five distinguished American authorities elaborate on the cause, effect, transport, measurement and control of air pollution. It represents the combined experience and talents of authors drawn from such diverse fields as chemistry, physics, medicine, meteorology, engineering, toxicology, agronomy and law.

These volumes treat comprehensively the physical phases, chemical properties and magnitudes of such primary emissions as fine solids, coarse particles, and diverse compounds of nitrogen, sulphur, oxygen and the halogens, and compounds organic and radioactive. Each of the group of pollutants is treated at length and the latest related knowledge is also incorporated. However, it should not be surprising if the reader discovers a few concepts that have already undergone change, because of enhanced techniques and additional refinements. Such is the dynamic pace of the advance of human knowledge and discovery in a setting of constant techno-scientific changes.

Air pollution in urban areas is materially conditioned by the complexities of topography, altitude, temperature, wind velocity, the frequency and intensity of fogs and low clouds—in

\* *See Pollution*. Edited by Arthur C. Stern. (Academic Press, New York and London), 1962, Vol. 1. Pp. xviii + 656. Price \$ 20. Vol. II: Pp. xvi + 686. Price \$ 18.50.

short, by geographical, meteorological and atmospheric conditions, the study of which is very important to assess the potentials of air pollution. Therefore, an admixture of empiricism and theoretical reasoning, combined with models of atmospheric diffusion, have made possible to observe pollution levels on hourly, daily and monthly bases. Through analysis and synthesis of such data it has now become possible to understand the high level of atmospheric pollution over industrial areas. The involved techniques, procedures, methodology and theory are treated at length throughout the two volumes.

Man has been the most incorrigible disturber of the balance of nature. Just as he is responsible for the deserts that scar the global landscape, so is he guilty for the physical and chemical pollution of the atmosphere through the photo-chemical smog and thermonuclear fallouts of his own creation. There is unanimity among scientists—whether we refer to the acute situation in London, Los Angeles or in Kanto plain in Japan, which accommodates Tokyo and Yokohama—that, because the cities are cluttered with factories and their roads are jammed with gas vehicles, the very air their residents breathe is, slowly but surely, killing them. The chimneys belching acrid smoke and chemical fumes, the speeding cars spewing and disseminating oxides of nitrogen and assorted hydrocarbons are injurious to both life and materials. For example, carbon monoxide impairs the oxygen-carrying capacity of haemoglobin and makes it a primary pollutant, while carbon dioxide affects the cardiac control mechanism. Air, contaminated by oxides and hydrocarbons, when exposed to otherwise beneficent sunshine, has a malignant effect which further aggravates the situation. In such an atmosphere the sunlight sets up photochemical reactions releasing poisonous gases. The resulting product is "smog". The high incidence of chronic bronchitis in London, of naso-pharyngeal and optic irritation in Los Angeles, of crippling T-Y asthma in Japan and the rapid rise in lung cancer among metropolitan populations throughout the world, are all being ascribed to smog. The automobiles in Los Angeles release nearly 80% of smog-producing nitrogen oxides and hydrocarbons. Even the *after burners* compulsorily installed in California gas vehicles, do not entirely correct the state and circumstances of befouled air. The sure-fire solution for eliminating smog in Los Angeles appears to be the banning of gas vehicles from its roads!

Air pollution is the most serious problem to all organic life as well as to non-living materials. Air pollutants corrode metal, discolour building stone and paints, weaken textiles, crack rubber and cause deterioration of furniture and household articles. There is no way of assessing the cost in human life by way of ill-health, disease, suffering and premature death. However, a glimpse of the colossal material losses can be had from authoritative figures. It has been estimated that the amount of sulphur compounds emitted to the atmosphere from various sources is greater than the total world production from native sulphur and pyrites combined. A 1949 study reported that the direct economic loss to U.S.A., due to air pollution, was of the order of 1,500 million dollars. The U.S. Geological Survey places damage to merchandise and buildings at 500 million dollars per year. Economic losses in U.K., from the same cause, are of the order of 250 million pounds, annually. The London smog of 1952 caused the owner of one chain-store a loss of £ 90,000 in the disposal of his damaged goods. Thus we can see the serious effect of air pollution in the lives and economics of an industrial community.

Space only permits a synopsis of the items included in the two volumes under review. The first volume is divided into three parts. It covers: classification of problems, residual pollution products, atmospheric reactions, air ions, state of lower troposphere and dispersion of stack effluents. The second part details the effects of air pollution on materials, visibility, plants, animals and humans. Finally, part three elaborates on the techniques of measuring and monitoring air pollution. The subjects covered are: air sampling, testing and monitoring, air analysis, production of controlled test atmosphere, odour and its measurement, meteorological measurements, automatic instrumentation and air pollution survey.

The second volume carries the balance of the fourth, fifth, sixth and seventh parts. Part four covers the entire range of air pollution sources, namely, combustion in furnaces, incinerators and open fires; automotive, industrial and petroleum refinery emissions; manufacture of acids and alkalis; sources of radioactive and natural air pollution. Part five, which deals with control methods and equipment, includes the following subjects: process and source control; efficiency and selection of collectors; source control by centrifugal force and gravity, by filtration, by electrical, thermal and sonic forces, by liquid scrubbing and solid absorp-

tion; nuisance abatement by combustion and, finally, water pollution potential of air pollution control devices. Part six deals with control administration including planning and zoning; legislation, standards, inspection and survey; source approval and registration; public education; co-operation and voluntary control activities; personnel and its qualification and training. The concluding chapter provides the reader with suggestions regarding books, proceedings of conferences and symposia, periodical literature, specialized and generalized bibliographies and abstracts.

In all, the two volumes carry 42 chapters. Each chapter concludes with a list of references meant to be helpful for further study and research. Each volume carries its own author and subject index. Both volumes make excel-

lent use of tables, charts, graphs, pictures and drawings to enliven and implement the clarity of concepts transmitted through cold print. In an increasing industrialising country like ours, air pollution must necessarily be considered now as a potential problem of the future. Therefore these comprehensive volumes should prove a valuable guide for those engaged in checking and eliminating air pollution in our constantly expanding industrial complex. They should be accorded a place in the reference shelf of every Engineering College and Technological Institute. In a spirit of helpfulness, to forestall embarrassment, the reviewer directs the attention of the publisher to the fact that pp. 241-272 (both inclusive) were missing in Vol. I of the review copy.

BIJOLA D. PANTH.

## SYMPOSIUM ON SELECTION OF SITES FOR NUCLEAR REACTORS

A SYMPOSIUM on "Criteria for Guidance in Selection of Site for the Construction of Reactors and Nuclear Research Centres" was held at Bombay, from 11th to 14th March 1963, under the auspices of the International Atomic Energy Agency (IAEA). The Atomic Energy Establishment of the Government of India played the host to the symposium which was held at the Tata Institute of Fundamental Research, Colaba, Bombay. It was attended by 116 participants from twelve countries, besides the representatives of FAO, WHO, ISO and WMO. 32 papers were presented at the symposium by the authors or their representatives.

The symposium was inaugurated by Mr. M. S. Karmachar, the Chief Minister of Maharashtra. The role of Public Health authorities in the selection of sites for nuclear reactors was explained by Mr. Halper of the WHO. Mr. Warkley of the FAO gave a short discourse on the impact of atomic reactor sites on agricultural interests. He also elaborated on the various factors involved in the movement of radio nuclides through the atmosphere-soil-vegetation animal-human chain and concluded that the risk from the atomic industry, so far, has been much lower than what it has been in the coal industry. The subjects discussed in the remaining six sessions of the symposium related to:

1. Site selection with particular reference to (a) Air-borne radioactivity and (b) Ground considerations; 2. Containment as it affects site selection; 3. Criteria for site selection; 4. Experience related to site selection for (a) Nuclear Centres and (b) Power Stations.

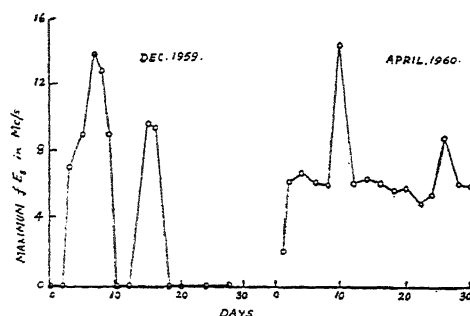
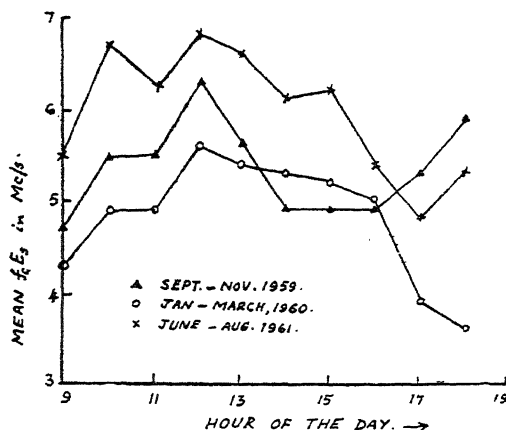
The use of meteorological parameters in site selection and subsequent operation of nuclear reactors were discussed at some length in six papers presented at the symposium by U.S.A., France and India. Many papers which were presented at the symposium, however, emphasised the "Containment" aspect of the radio nuclides within the facility and thereby preventing the contamination of the atmosphere. Once this is done satisfactorily, the role of Meteorology in site selection and subsequent operation of various nuclear reactors would become small. The papers presented by the members of the A.E.E., India, dealt with the selection of the proposed nuclear power reactor sites in India. The presentation of papers was followed by interesting discussions.

At the close of the symposium two panel discussions were held, the first on "Review, Assessment and Personal Impressions of the Material Presented" and the second on "Predictions of Future Trends in Site Selection Criteria, Procedures and Practices".

## LETTERS TO THE EDITOR

STUDIES ON SPORADIC E-RELATION  
SHIP WITH THUNDERSTORMS AND  
MAGNETIC DISTURBANCES

THE critical frequency of the sporadic E is noted at regular intervals of 1 hour during daytime, every day for 3 different seasons, the periods being September to December 1959, January to May 1960 and June to September 1961. The variations of the monthly mean critical frequency and the number of times the  $E_s$  appears during the daytime are recorded. The variation of mean critical frequency for different seasons is shown in Fig. 1. It is clear from this figure that the maximum ionization occurs at noon for all the seasons. The ionization increases as the zenith angle of the sun



FIGS. 1-2. Fig. 1. Diurnal variation of  $fE_s$ .  
Fig. 2. Daily variation of maximum  $fE_s$ .

decreases, reaches a maximum around noon and decreases afterwards. The curves show that there is a tendency for the ionization to increase

-again in the evening hours for the months September to November, 1959, and June to August, 1961. There is no such tendency for the ionization to increase again in the evening hours, for the months January, February and March, 1960. The curves also show that maximum ionization occurs during July to August and the minimum during January to March. In an earlier communication<sup>1</sup> it has been shown that at this station patchy type of  $E_s$  is predominant during daytime. The same characteristics are revealed in the present series of observations also.

Intense ionization has been observed in December 1959 and April 1960 (Fig. 2). In December 1959 our observations show that  $E_s$  activity is practically non-existent on most days but it is very intense on a few days and that too at certain hours on these days. Meteorological records show that on these days and at these hours there was large thunderstorm activity in the region of the station. This indicates that due to thunderstorm activity intense but passing clouds of ions were probably formed. This observation of ours does not conform to the general pattern for low latitude stations as reported by Rangarajan.<sup>2</sup>

In April 1960 it was reported<sup>3</sup> that moderate to severe magnetic disturbances occurred from 1st to 5th April 1960. It is quite possible that these disturbances were responsible for the intense  $E_s$  activity observed during this month. If so it must be admitted that there is a large time lag between the two sets of activities. (Magnetic 1st to 5th April, Ionospheric 10th April.)

I am grateful to Dr. J. Bhimasenachar for his guidance and encouragement. My thanks are due to the authorities of S. V. University for providing me all facilities in carrying out these investigations.

Dept. of Physics, M. J. KESAVA MURTHY.  
Sri Venkateswara University,  
Tirupati, February 22, 1963,

1. Kesava Murthy, M. J., *Curr. Sci.*, 1962, 31, 233.
2. Rangarajan, J. *Geophys. Res.*, 1954, 59, 239.
3. Overseas Communication Service, Bombay and Kodaikanal Observatory, *The Hindu*, Dated 2-4-1960.

# RELATION BETWEEN THE GENESIS AND THE GRAIN SIZES OF THE CONSTITUENTS IN LIMESTONES

It is recognised<sup>1</sup> that the composition and the grain sizes of the constituents of the sedimentary rocks are two basic properties that can be used with advantage in classifying them. In literature, information regarding the accurate measurement of grain size in sedimentary rocks is meagre, probably because the fine grains of these rocks are not amenable to the usual optical examination. Hence, the authors have recently developed and used X-ray methods<sup>2,3</sup> to determine the grain sizes and the composition of several types of rocks. This communication presents the trend of the results obtained in the case of limestones belonging to three regions of South India.

The three regions from which the limestone samples have been collected are Huzurnagar (Palnad basin) and Paniam (Kurnool basin) of Andhra Pradesh and Chincholi (Bhima basin) of Mysore. The sediments of all the three basins belong to the Precambrians. A preliminary X-ray examination showed that the main constituents of all these limestones are calcite and quartz. Chemical analysis revealed only minute traces of  $MgCO_3$ . The distribution of spots on the Debye-Scherrer rings corresponding to 104 reflection of calcite and 101 of quartz, obtained on X-ray transmission photographs of thin sections of the specimens, have been used to determine the grain sizes of calcite and quartz. Figure 1 shows the characteristic X-ray patterns of limestones belonging to the three regions.

In the case of Huzurnagar samples, the diffraction rings of calcite and quartz are both spotty. Calculation showed that the grain sizes of calcite and quartz are nearly the same, thereby indicating a good sorting of grains by a mechanical process. The grain sizes of the two minerals are of the order of 0.06 mm. It is also found that the quartz content of these samples is fairly large and comparable to that of calcite present, which also suggests a mechanical process. If both calcite and quartz were chemically precipitated at the site of deposition, one would expect a smaller amount of quartz in the samples. Hence, the Huzurnagar limestones appear to be predominantly clastic in their origin.

In the photographs of Chincholi samples, the diffraction ring due to quartz is continuous showing that the size of the quartz particles is of the order of  $10^{-5}$  cm. One would not expect such fine grain size in detrital quartz. The

amount of quartz present is also small. These features indicate that the Chincholi deposits are chemical in their origin.

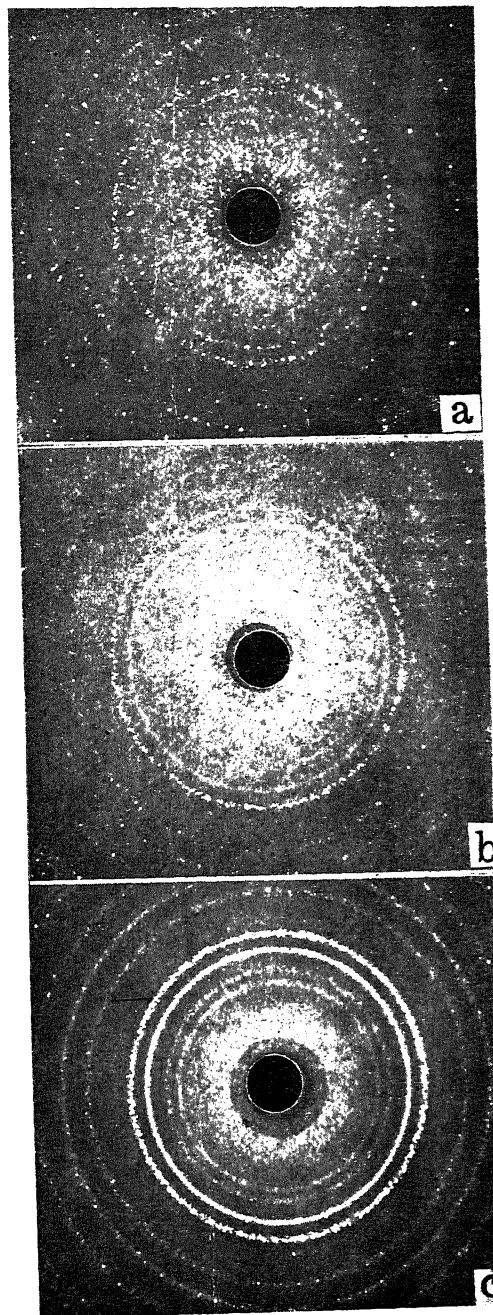


FIG. 1 (a-c). X-ray diffraction patterns of limestones. (a) Sample from Huzurnagar. (b) Sample from Chincholi. (c) Sample from Kurnool. The inner intense ring corresponds to 101 reflection of quartz and the outer one is due to 104 reflection of calcite.

The photographs of samples from Kurnool show a continuous quartz ring with a superposition of discrete spots. This shows that in these samples, detrital quartz grains are also present along with very fine quartz particles. Hence, it may be concluded that the origin of these limestones is of a hybrid nature, both the chemical and mechanical processes contributing to their formation. Thus it appears that the X-ray diffraction patterns of limestones indicate the order of the grain sizes of the constituent minerals and their distribution, the study of which in turn reveals the petrogenetic history of limestones themselves.

In conclusion, the authors wish to thank Dr. S. Balakrishna, Head of the Geology Department, for many useful discussions.

Physics Department, K. V. KRISHNA RAO.  
Osmania University, G. GOPALA KRISHNA.  
Hyderabad-7 (India),  
March 4, 1963.

1. Krynine, P. D., *Journal of Geology*, 1948, **56**, 386.
2. Krishna Rao, K. V. and Gopala Krishna, G., *Curr. Sci.*, 1960, **29**, 386.
3. — and —, *Indian Mineralogist*, 1962 (in the press).

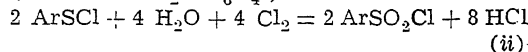
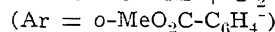
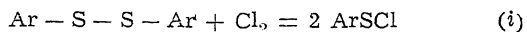
## HALOGENATION OF DISULPHIDES IN WATER

CHLORINATION of a vigorously stirred heterogeneous suspension of 2 : 2'-dimethoxycarbonyldiphenyl disulphide in water and carbon tetrachloride gives o-methoxycarbonylbenzenesulphonyl chloride,<sup>1</sup> in 95% yield; experiments on the mechanism of this reaction under the heterogeneous conditions were conducted.

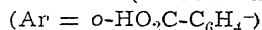
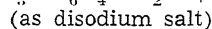
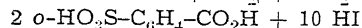
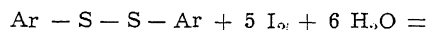
When 2 : 2'-dimethoxycarbonyldiphenyl disulphide was chlorinated under anhydrous conditions at 0–5°, it was observed that only one mole of chlorine was absorbed per mole of the ester, yielding o-methoxycarbonylbenzenesulphonyl chloride (b.p. 160–63°/6 mm. Found : Cl, 17.6; Calc. for  $C_8H_7O_2ClS$ : Cl, 17.5%) in 95% yield. This indicated that the stable compound which was formed under the experimental conditions was a monochloride and not a trichloride as observed by Douglass *et al.*<sup>2</sup> in their

experiments with similar compounds. Passage of chlorine into a vigorously stirred heterogeneous suspension of the sulphenyl chloride, water and carbon tetrachloride yielded o-methoxycarbonylbenzenesulphonyl chloride in 98% yield. In this case, the rate of absorption of chlorine was the same as the rate of formation of hydrochloric acid.

Further, it was observed that when the heterogeneous mixture of the diphenyl disulphide, carbon tetrachloride and water was chlorinated, there was negligible formation of any hydrochloric acid till nearly 20% of the chlorine (corresponding to 2 g. atoms of chlorine per g. mole of the disulphide) was absorbed; and, after the initial one-fifth intake of chlorine every further quantity of chlorine generated an exact equivalent of hydrochloric acid (Table I) indicating that in the chlorination of the disulphide in water the primary intermediate product was the sulphenyl chloride formed by the cleavage of the sulphur-sulphur bond.<sup>3</sup>



When 2 : 2'-dicarboxydiphenyl disulphide was oxidised with iodine in a strongly alkaline solution there was a very rapid absorption (within one minute) of 9.4 to 9.7 atom equivalents of iodine and about 13.5 equivalents of alkali (the reaction mixture was titrated using phenolphthalein as indicator) were taken up per mole of the disulphide, indicating that the sulphonyl iodide formed had hydrolysed to the sulphonic acid.



.. (iii)

When the oxidation of the dicarboxydiphenyl disulphide with iodine was effected with lesser quantity of alkali (4 to 6 equivalents), there was a very rapid absorption (within 30 seconds) of 6 equivalents of iodine and there was formed 10 equivalents of acid (the reaction mixture was titrated using phenolphthalein as indicator);

TABLE I

0.10 Mole of o, o'-Dimethoxycarbonyldiphenyl disulphide was taken.

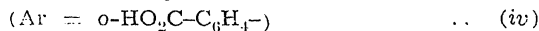
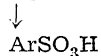
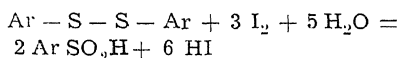
Time (minutes)	5	10	20	30	40	50	60	70	80
Atom equivalents of chlorine (Cl)	0.093	0.219	0.320	0.456	0.613	0.731	0.850	0.925	0.965
Equivalents of Hydrochloric acid (HCl)	0.006	0.019	0.150	0.266	0.413	0.529	0.660	0.747	0.825

after which the rate of reaction slowed down considerably with an equivalent amount of acid being formed for each equivalent of iodine that was consumed (see Table II). This can best be explained by the hydrolysis of the intermediate sulphonyl iodide ( $\text{ArSOI}$ ) to the sulphinic acid, which is comparatively slowly oxidised to the sulphonic acid under the experimental conditions.

TABLE II

0.010 Mole of *o, o'*-Dicarboxyphenyl disulphide was taken.

Time (hours)	0.1	0.5	1	4	10	16
Atom equivalents of Iodine (I) consumed	0.064	0.071	0.075	0.086	0.091	0.093
Equivalents of acid formed	0.103	0.109	0.113	0.126	0.131	0.132



Douglass *et al.*<sup>1</sup> have suggested the possibility of formation of such a sulphinic acid if water were to be present in the chlorination of methanesulphonyl chloride.

We are deeply indebted to the Research and Development Section, Sarabhai Chemicals, for certain preliminary investigations.

Sarabhai Chemicals,  
Baroda, March 25, 1963.

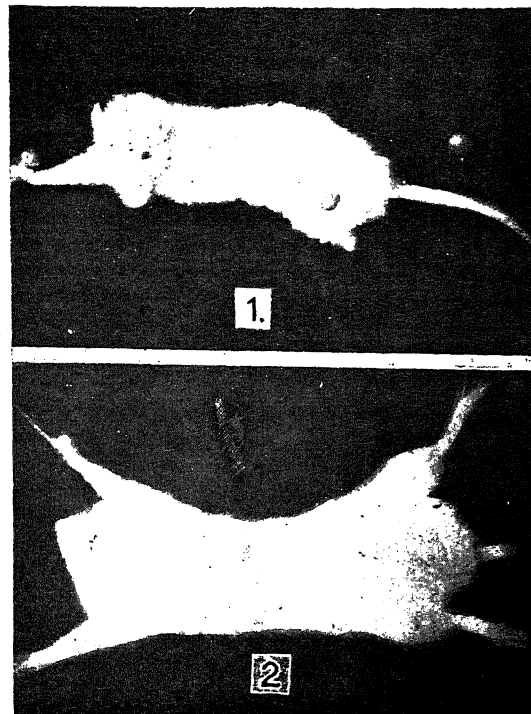
G. BAGAVANT.  
G. M. PARIKH.  
B. SREENIVASAN.

1. Lee and Dougherty, *J. Org. Chem.*, 1940, 5, 81.
2. Douglass and Farah, *Ibid.*, 1958, 23, 330.
3. Stirling, *J. Chem. Soc.*, 1957, 3597.
4. Douglass, Farah and Thomas, *J. Org. Chem.*, 1961, 26, 1997.

### RADIATION INDUCED CONGENITAL DEFECTS IN ALBINO RATS

DURING the course of our study on the rate of healing of bone fractures in albino rats and the comparative efficacy of the indigenous drug *Cissus quadrangularis* thereon, two series of experiments were conducted employing radioactive isotopes, sulphur-35 and phosphorus-32, for intraperitoneal injection at different stages of the healing. Results of these experiments have been published earlier.<sup>1</sup> During this work it was discovered that one of the rats which had received an injection of 50 microcuries of P-32 in the form of carrier-free sodium

hydrogen phosphate buffered to a pH of 5.6 was pregnant and its scheduled sacrifice was therefore abandoned. Her body weight was 80 gm. initially and she gave birth to four baby rats in normal time after two weeks. All these baby rats are found to be genetically deformed, two with three legs, one missing the hind and the other the fore leg, and two with very short tails. They are otherwise normal and living. The photographs (Figs. 1 and 2) were taken



FIGS. 1-2. Two of the four genetically deformed albino rats born to a mother rat who had received a dose of P-32 intraperitoneally during pregnancy. Two of them are 3-legged (as in Fig. 1) and in two the tail is underdeveloped (as in Fig. 2). Photographs were taken when they were 20 months old.

when they were about 20-21 months' old. Further study on the subject is in progress.

College of Medical Sciences, H. J. ARNIKAR,\*  
Banaras University, L. M. SINGH.  
February 18, 1963. K. N. UDUPA.

\* Present address: Department of Chemistry, University of Poona.

1. Arnikar, H. J., Singh, L. M. and Udupa, K. N., *Ind. J. Med. Sci.*, 1961, 15, 545 and 551.

# OCCURRENCE OF SOME LARGE FORAMINIFERA IN THE CRETACEOUS ROCKS NEAR VRIDHACHALAM, MADRAS

## INTRODUCTION

DURING recent field-work in the Vridhachalam Cretaceous area, about 70 samples were collected for Palaeontological and stratigraphical study of the area. The Cretaceous beds of Vridhachalam are part of the Trichinopoly Cretaceous and these have been described by Blanford,<sup>1</sup> Warth,<sup>2</sup> Kossmat,<sup>3</sup> Rama Rao<sup>4</sup> and Avograswamy.<sup>5</sup> However, the microfossils of this area have not so far been described. This paper gives a short account of the Cretaceous Orbitoids found in this area.

This report is based on the material collected from Trumanur (11° 33' : 79° 18') 3 miles north-west of Vridhachalam. In this area sandstones and calcareous shales are the major members of the Cretaceous beds. In shales a rich collection of Orbitoids were made. A number of well-centered median and vertical sections were prepared.

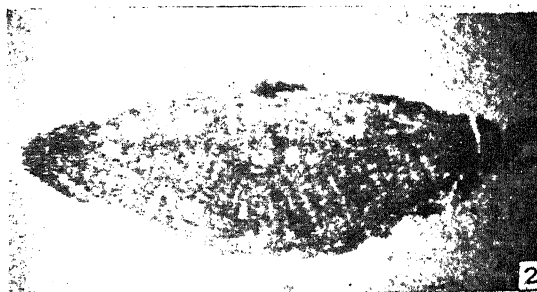
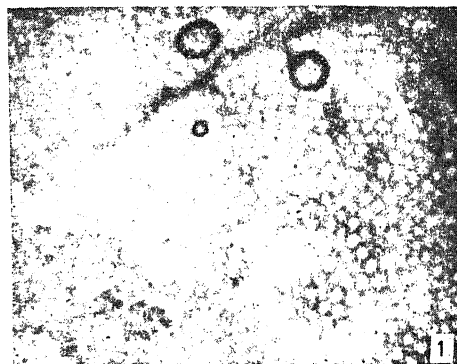
The orbitoidal fauna is represented by two genera, namely *Lepidorbitoides* and *Orbitoides* (?). The occurrence of these genera suggests that the beds belong to Maastrichtian in age. Similar occurrence of these two genera has been reported from the Upper Ariyalur beds of the Trichinopoly Cretaceous by Narayana Rao<sup>6</sup> and Rama Rao.<sup>7</sup> Detailed work on the Orbitoids will be published later.

Genus *Lepidorbitoides* A SILVESTRI, 1907  
(Figs. 1-4)

The circular test is lenticular. Both symmetrical and asymmetrical forms are commonly found. Most of them are ornamented with reticulate pits whereas the others are ornamented with reticulate pits and granules. A few of them are smooth. Usually the diameter is 1.5 to 3.5 mm. but rarely it is 4 to 5 mm. The thickness varies from 0.4 to 1 mm.

In median sections, the nucleoconch is bilocular with a spherical proloculus and a reniform deuterolocus. The nucleoconch is covered by a thick common wall and surrounded by two unequal primary auxiliary chambers on either side of the boundary between the proloculus and the deuterolocus and by biserial neptenic chambers. The spatulate equatorial chambers have their pointed ends towards the centre and are arranged in concentric circles alternating with those of the preceding and succeeding ones.

In vertical sections, the lateral chambers are arranged in regular tiers, which vary in number from 8 to 14. In specimens having granules, the tiers of the lateral chambers are traversed by pillars, which are absent in specimens without granules.



FIGS. 1-4. *Lepidorbitoides*,  $\times 33$ . Fig. 1. Equatorial section. Figs. 2-4. Vertical sections.

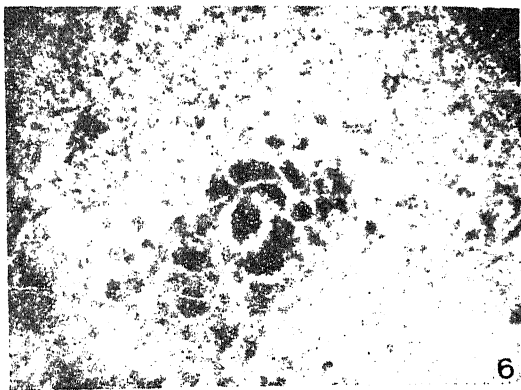
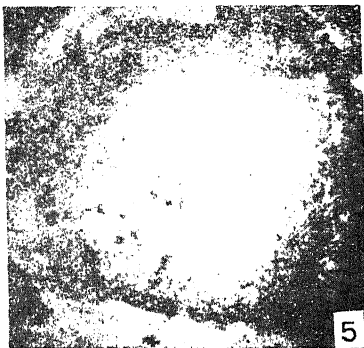
Remarks.—In this material two forms occur abundantly. Some of the forms having reticulate pits with uniformly distributed granules are



similar to *Lepidorbitoides minor* (Schlumberger) whereas the others having either smooth surface or reticulate pits, resemble closely *Lepidorbitoides inornata* Narayana Rao. It seems, therefore, that the ornament furnishes a criterion for specific identification but not for a generic one.

(?) GENUS *Orbitocyclina* VAUGHAN, 1929  
(Figs. 5-6)

The thin lenticular test is circular and symmetrical with smooth surface. The diameter of the test varies from 1.9 to 2.5 mm. and the thickness from 0.6 to 0.9 mm.



FIGS. 5-6. (?) *Orbitocyclina*. Equatorial sections. Fig. 5,  $\times 25$ ; Fig. 6,  $\times 70$ .

In median section, the nucleocoel is bilocular with a spherical proloculus and a sub-spherical deuteroecolus followed by a helical spiral of 10 to 11 periembryonic chambers.

The subrectangular periembryonic chambers gradually increase in size and are bigger than the equatorial chambers. The periembryonic chambers and the nucleocoel are connected by small chambers. The spatulate equatorial chambers are arranged in concentric circles and alternate with those of the preceding and succeeding ones.

Remarks.—Out of the two specimens found, one is broken along the equatorial plane showing both the embryonic and the equatorial chambers. The equatorial section of the second specimen was made. It is, therefore, not possible to study the vertical section of this form.

This form resembles *Orbitocyclina ariyalurensis* Narayana Rao, reported from the Upper Ariyalur beds of the Trichinopoly Cretaceous. Hanzawa<sup>8</sup> considers that this form may be assigned to his new genus *Pseudorbitella* but not to *Orbitocyclina* Vaughan, which according to him is characterised by the B-type nepionic chambers. Therefore the generic name of this form is doubtfully placed under the genus *Orbitocyclina*.

Dept. of Geology,  
University of Madras,  
December 26, 1962.

D. A. RASHEED.  
A. GOVINDAN.

1. Blanford, H. F., *Mem. Geol. Surv. Ind.*, 1865, 4.
2. Warth, H., *Rec. Geol. Surv. Ind.*, 1895, 28.
3. Kossmat, F., *Ibid.*, 1895, 28.
4. Rama Rao, L., *Proc. Ind. Acad. Sci.*, 1956, 44, 4.
5. Arogyaswamy, R. N. P., *Geol. Surv. Ind. Report*, G.O. No. 234, 1958.
6. Narayana Rao, S. R., *J. Mys. Univ.*, 1942, 2B.
7. Rama Rao, L., *Proc. Ind. Acad. Sci.*, 1957, 45, 6.
8. Hanzawa, S., *Micropalaeontology*, 1962, 8, 2, 151.

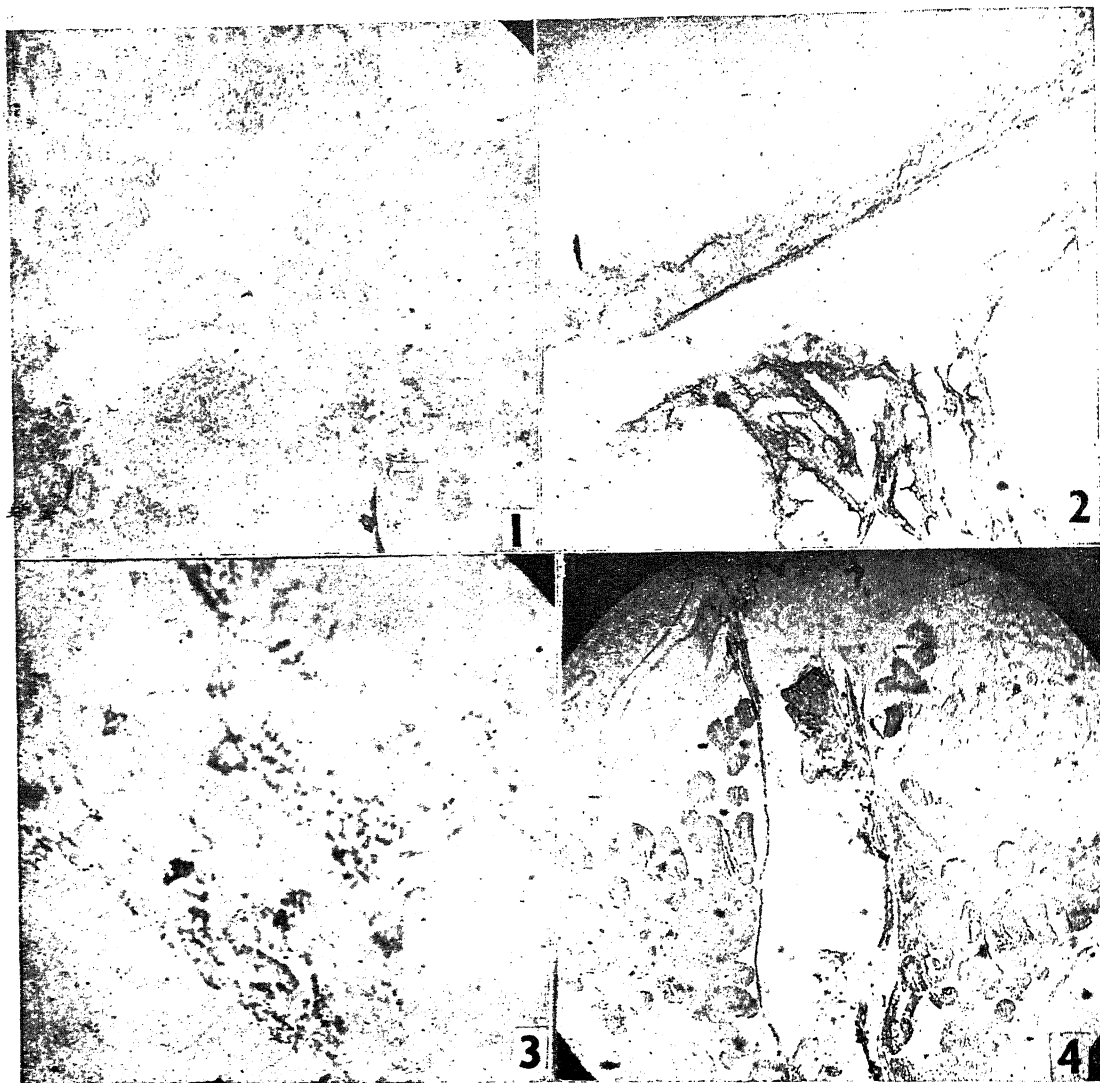
#### THE DISTRIBUTION OF GLYCOGEN IN *MARTESIA FRAGILIS*, A COMMON WOOD-BORER OF MADRAS

THE glycogen content in *Teredo* (*Lyrodus*) *pedicellata* and in *Martesia striata* have been reported.<sup>1,2</sup> Recently Srinivasan<sup>3</sup> gave a detailed account of the glycogen reserves in *Martesia fragilis* in relation to size and sex. A study of its distribution in different tissues is of equal importance in understanding the carbohydrate metabolism of this animal. The methods of Steedman<sup>4</sup> and Glick<sup>5</sup> were followed in the preparation of sections for histochemical studies. Staining by carmine (best carmine) gave satisfactory results.

It was found that the concentration of glycogen was high and was distributed over the entire animal, though in certain areas, like gills, mantle, muscles and the digestive diverticula it was more abundant. The tubules of the digestive diverticula (Fig. 1) have been found to contain large deposits of glycogen and were more darkly stained than the neighbouring areas. These areas are restricted to the dorsal and ventral regions of the visceral mass probably due to its being the centre for intra-

cellular digestion of food material. In the gills (Fig. 2) glycogen deposits are denser in the non-ciliated regions than in the ciliated ones. The mantle (Fig. 3) shows considerable concentrations, especially towards the inner ciliated mantle epithelium. The ventral regions

of higher glycogen deposition are apparently much the same as in *Teredo pedicellata* (Lane *et al.*).<sup>1</sup> However unlike in *Teredo pedicellata*, in *M. fragilis* the epithelium of the tubules of the digestive diverticula are also rich in glycogen stores.



FIGS. 1-4. Showing the distribution of glycogen in the digestive diverticula (1), the gills (2), the mantle (3) and the intestines, gut and the Style-sac (4).

of the mantle are more heavily laden than the dorsal regions. The intestines, gut and the style-sac (Fig. 4) are lightly stained and have lesser glycogen reserves. They exhibit granular particles of glycogen.

In *M. fragilis*, it may be seen that the areas

I thank Dr. S. Krishnaswamy for guidance and Prof. C. P. Gnanamuthu, Director, for his encouragement. To the authorities of the Forest Research Institute, Dehra Dun, I acknowledge my indebtedness for their financial assistance.

Marine Organisms Scheme, V. V. SRINIVASAN.  
Zoology Res. Laboratory,  
University of Madras,  
October 25, 1962.

1. Lane, C. E., Posner, E. G. S. and Greenfield, L. J., *Bull. Mar. Sci.*, 1952, 2, 385.
2. Nagabushanam, R., *J. Sci. Ind. Res.*, 1961 c, 20 C (6), 171.
3. Srinivasan, V. V., *Proc. Ind. Acad. Sci.*, 1963, 57, 124.
4. Steedman, H. F., *Quart. J. micr. Sci.*, 1947, 88, 123.
5. Glick, D., *Techniques of Histo- and Cyto-chemistry*, Interscience Publ., 1949.
6. Bensley, C. M., *Stain. Tech.*, 1939, 14, 47.

### ELASTIC CONSTANTS OF SOME VOLCANIC ROCKS FROM JAPAN

VOLCANIC ROCKS from old soma lava, young soma lava and central cone lava have been studied for their mineralogical characters and physical properties. Thin section study of these rocks indicates that plagioclases range from oligoclase to labradorite, the latter being the more common type of feldspar. Plagioclase shows zoning which is not due to submicroscopic twinning but due to successive layers of different plagioclase feldspars exhibiting a change from a more basic variety in the centre to a more acidic one at the margin. They are often idiomorphic and tabular showing albite lamination frequently associated with winning on Carlsbad law. Rhombic pyroxene in the lavas is hypersthene. Few grains of augite are also found as idiomorphic crystals. Olivine occurs as an accessory mineral with oxides of iron scattered here and there in all thin sections. The ground mass has the distinctive 'felted' character consisting of innumerable laths of feldspar and pyroxenes even showing flow structures. Feldspars and pyroxenes of the ground mass belong to the second generation while phenocrysts belong to the first generation. Average density of these andesitic lavas ranges from 2.3 to 2.8.

Longitudinal ( $V_L$ ) and torsional ( $V_T$ ) ultrasonic velocities in km./sec. have been determined in some specimens of andesitic lavas by the wedge method. Elastic constants have been calculated and are tabulated in Table I along with locality and densities.

Table I suggests that average velocity value ( $V_L$ ) in Japanese andesitic lavas lies about 5.8 km./sec. and that they are all fine-grained rocks characterised by flow structures belonging to recent age. It is interesting to see that Deccan Traps of Volcanic origin exhibit a velocity value ( $V_L$ ) in the region of 6.8 km/sec. This difference

is very marked and perhaps deserves some attention. Presumably this may be attributed to mineralogical differences and also to the long geological history that has gone by in the case of Indian Deccan Traps.

TABLE I  
Elastic constants of andesitic lavas

Sl. No.	Locality	$\rho$	$V_L$	$V_T$	Y	$\mu$	$\sigma$
1	Nagao-Toge ..	2.79	5.85	3.06	6.9	2.6	0.31
2	Hakone-Toge	2.69	5.81	2.80	5.7	2.1	0.35
3	Nagao-Toge ..	2.95	4.94	2.36	4.4	1.6	0.34
4	" ..	2.75	5.51	2.68	5.9	2.2	0.32
5	" ..	2.76	5.99	2.16	7.2	2.5	0.31
6	" ..	3.06	5.42	2.66	5.8	2.1	0.34
7	Sukumogave ..	2.73	5.14	2.97	6.0	2.4	0.25
8	Natovokone ..	2.62	4.71	2.41	4.0	1.5	0.32
9	Asimoyu ..	2.32	5.23	2.73	4.5	1.7	0.32
10	Motahakone ..	2.69	5.59	2.89	5.9	2.2	0.34
11	Hutagoyma ..	2.59	5.78	2.92	5.9	2.2	0.33
12	Asinoyukami-yama lava	1.61	5.28	2.54	2.8	1.0	0.35

1-3, 5, 7-9 are Hypersthene Augite Andesites, 4, 6, 10-12 are olivine-bearing Hypersthene-Augite Andesites. Y (Youngs modulus);  $\mu$  (Rigidity modulus) in  $10^{11}$  dynes/cm.<sup>2</sup> and  $\sigma$  (Poisson's ratio).

The authors are grateful to the Director, Geological Survey of Japan, Tokyo, for kindly sending the samples.

Geology Department, S. BALAKRISHNA.  
Osmania University, A. SURYAPRAKASA RAO.  
Hyderabad (A.P.), March 27, 1963.

### THE COMPOSITION OF EGG CAPSULES OF THE PULMONATE SNAIL *ARIOPHANTA LIGULATA* (FERRUSSAC)

INVESTIGATIONS on egg capsules of gastropods have been mostly with reference to their shape, structure and nature of formation. Little is known regarding biochemical aspects of the egg capsules. The only studies that seem to have been made so far are of George and Jura<sup>1</sup> on *Succinea putris*, and Jura and George<sup>2</sup> on *Succinea putris*, *Limnæa stagnalis* and *Planorbis cornus*.

The present note deals with the chemical composition of the egg capsule of a common pulmonate snail of South India, *Ariophanta ligulata*.

For determining the presence of carbohydrates and mucopolysaccharides the periodic acid-Schiff (PAS) technique and toluidine blue staining<sup>3</sup> were used. For galactogen, method of Grainger and Shillitoe<sup>4</sup> was employed. Standard Millon's reaction for protein, ninhydrin reaction for amino-acid, and Sudan Black-B in 70% alcohol for lipids were used.

The capsules appear vesicular measuring from 5 to 6 mm. in length and from 2.5 to 3.0 mm. in width. The capsular wall is composed of an outer membrane and an inner envelope made of very viscous and transparent jelly-like substance. This encloses the capsular fluid in which is contained the embryo. The capsular membrane, jelly and capsular fluid were tested for proteins, carbohydrates, fat and calcium. The results of the analysis are shown in Table I.

TABLE I

Substance	Capsular membrane	Jelly	Capsular fluid
Protein	.. +++	++	++
Tyrosine-containing protein	.. +++	++	+
$\alpha$ -amino acids	.. -	++	++
Acid mucopolysaccharides	.. +++	+++	-
Galactogen	.. -	-	+++
Glycogen	.. -	+	+
Fat	.. -	-	-
Calcium	.. +++	+++	-
Calcium carbonate crystals	.. +++	-	-

+ Present.

- Absent.

It will be seen from Table I that there are some interesting differences in composition between the capsular membrane, jelly and capsular fluid.

The capsular membrane contains proteins including tyrosine-containing proteins, acid mucopolysaccharides, calcium including crystals of calcium carbonate, but, amino-acids, glycogen and fat are lacking.

The composition of jelly differs from that of capsular membrane in the presence of amino-acids, glycogen and in the absence of crystals of calcium carbonate. Acid mucopolysaccharides are abundant as in the capsular wall.

The capsular fluid differs from the jelly in having galactogen and in the complete absence of calcium, and acid-mucopolysaccharides. The concentration of tyrosine-containing proteins is lowest in the capsular fluid and highest in capsular membrane.

Observations on the formation of metachromasia with toluidine blue were made both before and after decalcification with EDTA. It was found that metachromatism is prominent after decalcification only. This indicates the calcium binding capacity of acid mucopolysaccharides.<sup>5-8</sup>

The capsular fluid serves as a nutrient medium for the developing embryo, but it seems probable that the calcium required for the developing embryo is derived from the capsular membrane and jelly.

My thanks are due to Dr. V. R. Meenakshi who suggested the problem. I also thank Prof. R. V. Seshaiiah, Marine Biological Station, Porto-Novo, for critically going through the manuscript and for his suggestions. I am grateful to Prof. P. N. Ganapati, Head of the Department of Zoology, for giving me the necessary facilities.

Department of Zoology,  
Andhra University,  
Waltair, November 19, 1962.

K. RANGA RAO.

1. George, J. C. and Jura, Cz., *Proc. Ned. Akad. Wetens. Amst.*, 1958, **61 C** (5), 599.
2. Jura, Cz. and George, J. C., *Ibid.*, 1958, **61 C** (5), 590.
3. Pearse, A. G. E., *Histochemistry*, J. and A. Churchill Ltd., London, 1961, Pp., 1-998.
4. Grainger, J. N. R. and Shillitoe, A. J., *Stain Tech.*, 1952, **27**, 81.
5. Meenakshi, V. R. and Scheer, B. T., *Science*, 1959, **130**, 1189.
6. Simkiss, K. and Tyler, C., *Quars. J. micr. Sci.*, 1957, **58**, 19.
7. —, *Ibid.*, 1958, **59**, 5.
8. —, *Ibid.*, 1959, **100**, 529.

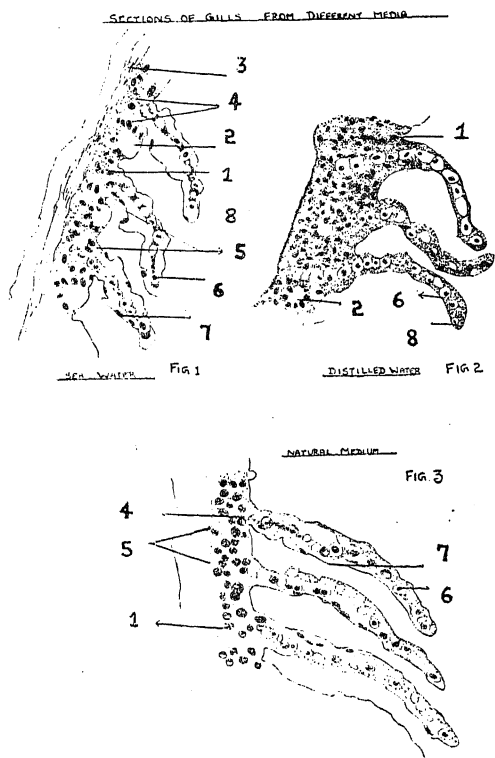
#### CHANGES IN THE INTER-LAMELLAR AND BASI-LAMELLAR PORTIONS OF THE GILLS OF *THERAPON JARBUA* WHEN EXPOSED TO VARYING SALINITIES

AN increase in the number of "chloride cells" in the gills of fishes, as a result of acclimatisation to varying salinities has been reported by many investigators.<sup>1-5</sup> While working on the chloride regulation of the brackish-water fish *Therapon jarbua*, it was observed that the fish can live both in sea-water and freshwater after gradual acclimatisation. The "chloride-cells" appear to be absent in this fish. There is however an increase or decrease in the number of the epithelial cells of the inter-lamellar and basi-lamellar portions of the gill. In the fish taken from the natural medium the mean number of nuclei is  $14.85 \pm .07$ . Those transferred to distilled water showed an increase in the number of nuclei (Mean No.  $16.40 \pm .03$ ). But those exposed to sea-water showed a decrease (Mean No. of nuclei  $10.68 \pm .04$ ).

To find out whether the above-mentioned difference in the number of nuclei is due to any regulatory mechanism, fish were taken from the natural medium, the gills of one side were fixed in a suitable fixative, and the gills of the other side were kept aerated for a limited period of time in either sea-water or distilled water as the case may be, and then fixed,

TABLE I

Features	Natural medium (16.05‰)	Experimental media	
		Sea-water (32.2‰)	Distilled water (0.5‰)
Vesicles	Vesicle absent in the inter-lamellar portion of the gill (Fig. 3)	Vesicles present in the inter-lamellar areas and the nuclei get arranged in the form of a ring around the vesicles (Fig. 1)	Vesicles present. Resemble of the sea-water picture in structure. But their position is different in that they are found deep inside in the inter-lamellar area (Fig. 2)
The number of nuclei in the inter- and basi-lamellar areas	Mean No. per unit area $14.85 \pm .07$	Mean No. per unit area $10.68 \pm .04$	Mean No. per unit area $16.4 \pm .03$
Shape of the nuclei	Round	Oval	Oval
Nature of the respiratory epithellum	The respiratory epithellum is clearly seen covering the finger shaped secondary lamellae rather tightly	The respiratory epithellum covers the secondary lamellae like a loose jacket with a large space in between	The respiratory epithellum is not seen clearly



FIGS. 1-3

(1) Nucleus. (2) Vesicle. (3) Blood vessel. (4) Basilamellar area. (5) Inter-lamellar area. (6) Blood cell. (7) Respiratory epithellum (or Basement membrane). (8) Secondary lamella.

in the same fixative. About 10 experiments were conducted. It was observed that the isolated gills could be kept alive and active in water for a period of more than two hours if

kept aerated. Care was taken to see that the bits of gills fixed and sectioned were taken from the identical portions of gills of either side of the fish. The isolated gills also exhibited similar variations in the number of nuclei in the inter-lamellar and basi-lamellar portions of the gill. This was noticed even in the gills exposed for very short period (30 mts.).

Besides the increase or decrease in the number of nuclei in the inter- and basi-lamellar portions of the gill exposed to various media, the changes were also noted (Table I).

These changes outlined above have not been so far reported in any fish. The mechanism causing the above changes is not yet known. Further investigation is proceeding.

I wish to thank Dr. S. Krishnaswamy for suggesting the problem and guidance.

Department of Zoology, T. V. VASANTHA.  
University of Madras,  
November 8, 1962.

1. Bavelander, G., *J. Morph.*, 1935, 57, 335.
2. Copeland, D. E., *Ibid.*, 1948, 82, 291.
3. Virabhadrachari, V., *Quart. J. Micr. Sci.*, 1961, 102, 361.
4. Rao, K. P., *The Bulletin of Biology*, 1962, 1, 1.
5. Vickers, T., *Quart. J. Micr. Sci.*, 1961, 104, 507.

#### SHIPWORMS FROM THE PULICAT LAKE, EAST COAST, MADRAS STATE

DURING the last 10 years our knowledge regarding the systematics and several aspects of the biology of marine timber-boring organisms of India has expanded considerably.<sup>1</sup> Not less than 28 species of shipworms, 2 species of *Martesia*,<sup>2</sup> 3 species of *Sphaeroma*<sup>3</sup> and 9 species of *Limnoria*<sup>1,4,5,12</sup> have so far been reported as

active in the Indian waters silently destroying a wide variety of underwater timber structures. Our present knowledge of Indian shipworms is chiefly confined to their depredations along the coastal areas especially from the harbours and estuarine regions<sup>6-9</sup> without any reference to their occurrence, abundance and activity in habitats such as the backwaters and lakes. These environments provide a variety of wooden substrata in the form of jetty-piles, stakes, dolphins, boats and semi-submerged tree stumps and other water-front structures for the settlement and growth of these pests. The present note deals with the occurrence of three shipworms from the Pulicat lake, the largest backwater on the east coast of Madras State. No shipworms have hitherto been recorded from the Pulicat lake. The collection is noteworthy since it contains 2 species not reported from the Indian coasts. One belongs to an interesting genus *Nausitora* some species of which are known to live in brackish water and even in freshwater.

In the present collection, the shipworms were recovered from submerged pieces of timber (*Thespesia* sp.) removed from a discarded country canoe during December 1960. The timber showed evidence of very heavy infestation and was riddled through and honeycombed converting it into a highly fragile mass almost sponge-like in appearance. Careful removal of the borers and subsequent study revealed the presence of at least 3 species of shipworms namely *Teredo* (*Teredo*) *australasiatica* Roch, *Teredo* (*Kuphus*) *manni* Wright (only shells and pallets) and *Nausitora hedleyi* Schepman. This collection is noteworthy since this is the first record for *T. australasiatica* from the Indian coast. This species has been previously reported from several localities on the east coast of Africa, namely Kenya (Mombasa), Tanganyika (Tanga, Pangani), Mosambique (Beira), Union of South Africa (East London) and also from Singapore. That the species has an extensive distribution in the Indo-Pacific area is evident from its occurrence in the Philippines, Caroline Islands, Mariannan and Midway Islands. *Teredo* (*Kuphus*) *manni* has been previously reported from India (Visakhapatnam, Madras and Bombay).<sup>10</sup> This is a common and destructive form with a wide distribution in the Indo-Pacific extending from the east coast of Africa, through Indonesia to Australia (Brisbane). The genus *Nausitora* is represented in the Indian waters by at least 3 species, namely *N. dunlopi* Wright, *N. Madra-*

*sensis* Nair and *N. gabrielei* Nair.\* Of these *N. dunlopi* has been reported from Madras and Visakhapatnam and also in almost fresh water in the Ganges delta.<sup>10</sup> *N. madrasensis* occurs in the catamarans used for fishing along the Madras coast while *N. hedleyi* has previously been recorded from the Vembanad backwaters as *N. gabrielei*.<sup>11</sup> The occurrence of *N. hedleyi* from the brackish waters of Pulicat lake indicates that this species can tolerate low salinities. In India only *Sphaeroma* and *Martesia* have attracted the notice as serious pests in brackish waters. *N. hedleyi* has a wide distribution and is known to occur in New Caledonia, Neapomern, Philippines, Java, Borneo, Sumatra and the Riouw Archipelago. Its occurrence along the Indian coasts extends its distribution further westwards into the Indian Ocean.

Thanks are due to Dr. Felix Roch, Museo Civico di Storia Naturale, Venezia, Italy, for help in the identification of the shipworms.

Oceanographic Lab., N. BALAKRISHNAN NAIR.  
University of Kerala,  
Ernakulam-6,  
October 15, 1963.

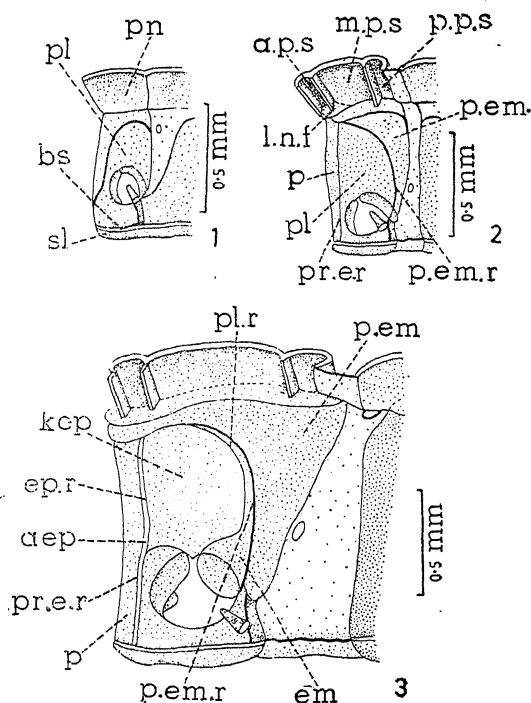
\* Probably a synonym of *Nausitora hedleyi*. Personal communication, Dr. Felix Roch, 1962.

1. Nair, N. B., *Journal of Scientific and Industrial Research*, 1961, **20 A** (10), 584.
2. Sreenivasan, V. V., *Proc. Indian Acad. Sci.*, 1959, **50**, 105.
3. Pillai, N. K., *Bull. Central Res. Institute, Trivandrum*, 1955, **4** (1), 127.
4. Ganapati, P. N. and Lakshmana Rao, M. V., *Curr. Sci.*, 1960, **29**, 275.
5. Pillai, N. K., *Bull. Central Res. Institute, Trivandrum*, 1957, **5** (11), 149.
6. Roonwal, M. L., *Curr. Sci.*, 1954, **23**, 301.
7. —, *Proc. Zool. Soc. Bengal*, 1954, **7**, 91.
8. Palekar, V. C. and Bal, D. V., *J. Bombay Nat. Hist. Soc.*, 1957, **55**, 962.
9. Ganapati, P. N. and Rao, M. V. L., *Curr. Sci.*, 1959, **28**, 332.
10. Becker, G., *F.A.O. Report*, 1958, **795**, 22.
11. Nair, N. B., *Rec. Ind. Mus.*, 1955, **53** (I-II), 262.
12. Pillai, N. K., *Wood-boring Crustacea of India*, Monograph Published by Government of India Press, Simla, 1961, **19**.

#### DEVELOPMENT OF PROTHORACIC SCLERITES IN *DYSDERCUS KOENIGII* (FABR.) (HETEROPTERA: PYRRHOCORIDAE)

THE prothorax of the nymph of *Dysdercus koenigii* is markedly different from that of the adult and during the course of its development the notal, sternal and pleural regions undergo not only an increase in their size but also show

a progressive differentiation into various sclerites. Detailed structure and development of prothoracic sclerites of *D. koenigii* will be published elsewhere while some observations and controversial points such as the formation of prothoracic flaps, attachment of cervical membrane and the intersegmental membrane between the pro- and mesothorax are described here.



FIGS. 1-3. Fig. 1. Prothorax of first instar nymph. Fig. 2. Prothorax of second instar nymph. Fig. 3. Prothorax of fifth instar nymph. a.p.s., anterior pronotal sclerite; a.e.p., anepisternum; bs., basisternum; em., epimeron; ep.r., episternal ridge; as., episternum; kep., katepisternum; l.n.f., lateral notal flap; m.p.s., middle pronotal sclerite; p., prepectus; p.e.m., postepimeron; p.e.m.r., post-epimeral ridge; pl., pleuron; pl.r., pleural ridge; pn., pronotum; p.p.s., posterior pronotal sclerite; pr.e.r., pre-episternal ridge; sl., sternellum.

The pronotum in the first instar nymph is a single piece (pn.) which in the second instar becomes marked off into very narrow anterior (a.p.s.) and posterior pronotal sclerites (p.p.s.) and a large middle sclerite (m.p.s.). The anterior pronotal sclerite gets fused with a semicircular piece, the prepectus (p.), which occupies the front part of the pleural and sternal regions of the segment. In successive instars proportionate enlargement of the posterior pronotal sclerite takes place and it is in

the late fifth instar that it becomes even larger than the middle sclerite as is the case in the adult. The fused anterior pronotal sclerite and prepectus form a ring-shaped sclerite which is demarcated from the middle sclerite by an internal ridge-like inflection. It is on this ridge that the cervical membrane is attached and in front of this level, the ring-shaped sclerite projects forward as a circular bar and covers the base of the head capsule. The ante-lateral margin in the second instar gets produced into a short lobe, namely the lateral notal flap (l.n.f.).

The pleuron of the prothorax, in the first instar nymph, also consists of a single sclerotic piece (pl.) connected to the pronotum by a narrow membrane. In the second instar, the region behind the prepectus is marked by a postepimeral ridge (p.e.m.r.) into two sclerites, of which the posterior is the rudiment of the post-epimeron (p.e.m.). The pleural (pl.r.) and pre-episternal (pr.e.r.) ridges appear in the fourth instar and it is in the fifth that the episternal ridge (ep.r.) makes its appearance when all the four regions of the propleuron, namely the anepisternum (aep.), katepisternum (kep.), epimeron (em.) and postepimeron (p.e.m.) are fully formed. The postepimeron is fused with the posterior pronotal sclerite to form a semicircular flap which covers the anterior part of the mesothorax, and marks a junction between the hind flap and the rest of the prothorax. The prosternum in all the five instars as in the adult is marked by a distinct furcasternal ridge into an anterior large basisternum (bs.) and a posterior sternellum (sl.).

There has been some controversy regarding the formation of the anterior and posterior flaps, the attachment of cervical membrane and the intersegmental membrane between the pro- and mesothorax. According to Malouf (1932) both the anterior and posterior flaps of the prothorax are evaginations in front of and behind the original segmental limits. He bases his conclusions on the fact that the intersegmental membranes are attached at the junctions of the two flaps with the middle region of the prothorax. Although Malouf has studied briefly the development of the thoracic sclerites of *Nezara*, he has not traced the details of the formation of flaps as mentioned above. Larsén's (1945 b) account of the post-embryonic development of thorax also does not give a clear idea about the formation of prothoracic flaps.

Observations on the ontogeny of the prothoracic sclerites of *Dysdercus koenigii* indicate

that regions corresponding to the anterior and posterior flaps of the adult insect become marked off as very narrow sclerites within the pronotum in the second nymphal instar. The ridges between these sclerites and the middle part of the segment are also quite distinct. The cervical membrane at this stage is attached to the front edge of the anterior sclerite, and the membrane between pro- and mesothorax to the hind edge of the posterior sclerite. It is later during the ontogeny that the front edge of the posterior sclerite also becomes reflected in and forward. The attachment of the intersegmental membrane thus shifts forward and this sclerite also takes the form of a flap. These observations discredit the views of Malouf and suggest that both the anterior and posterior prothoracic flaps are formed within the original limits of the segment.

I am indebted to Dr. K. N. Saxena under whose guidance the work was done and to Prof. B. R. Seshachar for providing working facilities in the laboratory.

Department of Zoology, SUDARSHAN KHANNA,  
University of Delhi,  
September 13, 1962.

1. Larsén, O., *Lunds. Univ. Arsskrift, N.F. Afd.*, 1945b, 2 (3), 41.
2. Malouf, N. S. R., *Bull. Soc. Roy. Ent. Egypt*, Cairo, 1932, 17.

#### ABERRANT FORMS IN TWO SPECIES OF *CULICOIDES* (DIPTERA: CERATOPOGONIDAE)

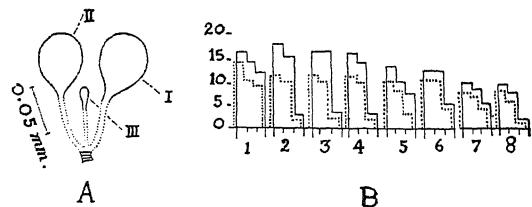
In the species of *Culicoides* with two functional and one rudimentary spermathecae, individuals simulating the spermathecal combination of the subgenus *Trithecoides* Wirth and Hubert through development of the rudimentary spermatheca into a bulbous one are regarded<sup>1</sup> as aberrant forms with atavistic genital structures. The present note reports the existence of such forms in *C. peregrinus* and *C. geminus* for the first time.

While rearing the imaginal forms belonging to *C. peregrinus* from the immature stages, spermathecae of 30 individuals of the species of different periods have been examined. Only one individual showed three fully developed spermathecae measuring (Length  $\times$  Breadth) as  $0.096 \times 0.084$  mm.,  $0.084 \times 0.06$  mm., and  $0.072 \times 0.054$  mm., and such a spermathecal combination indicates that it was an aberrant individual (Fig. B : 1). Remaining 29 individuals retained normal state with two func-

tional and one rudimentary spermathecae (Fig. A). In these normal forms, calculated mean lengths of the three spermathecae are,  $0.079 \pm 0.021$  mm. ( $0.108$  mm. —  $0.066$  mm.),  $0.071 \pm 0.019$  mm. ( $0.096$  mm. —  $0.06$  mm.) and  $0.025 \pm 0.016$  mm. ( $0.042$  mm. —  $0.018$  mm.) while the corresponding mean breadths are,  $0.059 \pm 0.014$  mm. ( $0.072$  mm. —  $0.042$  mm.),  $0.054 \pm 0.014$  mm. ( $0.066$  mm. —  $0.042$  mm.) and  $0.011 \pm 0.009$  mm. ( $0.024$  mm. —  $0.006$  mm.). A graded increase in size of the third spermatheca is noted and it follows that individuals of the species, with the third spermatheca not exceeding a length of  $0.042$  mm., are all normal in genital structures.

On the basis of varying lengths, 29 normal individuals of *C. peregrinus* exhibit 18 spermathecal combinations that impress only three broad trends (Fig. B : 2-6), viz., functional spermathecae equal (in 7 individuals) or subequal, with a length difference up to  $0.006$  mm., (in 12 individuals) or unequal (in 10 individuals) to each other. Extent of inequality is as low as  $0.018$  mm.

Range of variation in breadth does not always show correlation with that in length, in above cases (Fig. B : 1-6).



FIGS. A & B (1-8). Ventral view of the spermathecal apparatus in a normal *C. peregrinus* (A), and histograms (B) showing the spermathecal combinations in the same (1-6) and *C. geminus* (7-8), with line marks denoting lengths of three spermathecae and dotted areas their corresponding breadths, in a combination; figures on the ordinate indicate micrometer divisions one of which is equivalent to  $0.006$  mm.

While examining 4 females of *C. geminus*, all collected at Kuala Lumpur, Malaya, one aberrant form was detected. Spermathecal combination (Fig. B : 7) of the aberrant form measures (Length  $\times$  Breadth):  $0.054 \times 0.045$  mm.,  $0.048 \times 0.042$  mm., and  $0.03 \times 0.024$  mm. Calculated mean sizes of the same in normal forms of the species (Fig B : 8) are,  $0.05 \times 0.041$  mm.,  $0.041 \times 0.035$  mm., and  $0.011 \times 0.005$  mm.

Comments.—Previous works on *Culicoides* show aberrant forms in *C. (Macfiella) phlebotomus* (Williston) from Panama,<sup>2</sup> *C. (Oecacta) arubæ* Fox and Hoffman from Panama,<sup>3</sup> and



*C. (Oecacta) schultzei* (Enderlein) from Calcutta and areas around the city<sup>4</sup> as well as from Waltair (Southern India).<sup>5</sup> Present detection of the same in *C. (Culicoides) peregrinus* Kieffer from outskirts of Calcutta and *C. (Culicoides) geminus* Macfie from Malaya forms new addition to the list of *Culicoides* species where-in existence of aberrant forms with atavistic spermathecae has been reported so far.

I am grateful to Dr. S. Mookerji, Head of the Department of Zoology, Presidency College, Calcutta, for laboratory facilities, and to Dr. Wirth, of the U.S. National Museum, for the Malayan *Culicoides*.

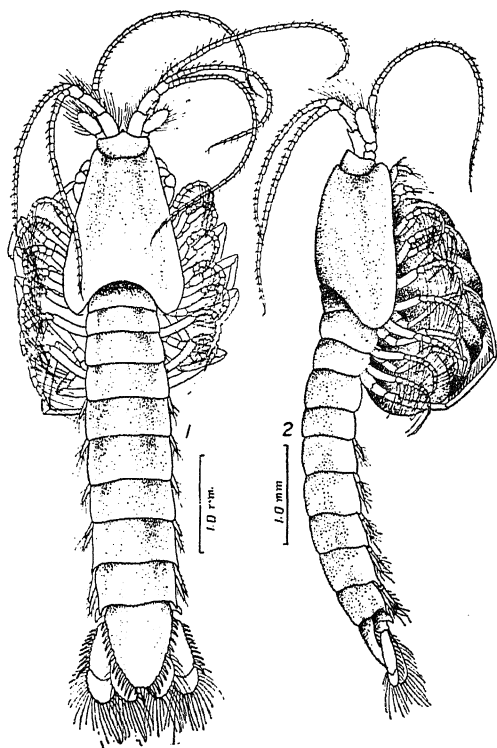
Zoology Department, S. K. DAS GUPTA.  
Presidency College,  
Calcutta, October 23, 1962.

1. Khalaf K., *Ann. Ent. Soc. America*, 1954, **47**, 34.
2. Wirth, W. W. and Blanton, F. S., *Entomol. News*, 1953, **64**, 113.
3. — and —, *Proc. U.S. Nat. Mus.*, 1959, **109**, 237.
4. Das Gupta, S. K. and Sen, P., *Indian Jour. Ent.*, 1958, **20**, 308.
5. —, *Sci. and Cult.*, 1962, **28**, 342.

#### ON THE DISCOVERY OF THE PRIMITIVE MYSIDACEAN FAMILY LEPIDOMYSIDAE IN INDIA

LEPIDOMYSIDS are a primitive group inhabiting subterranean waters. The family contains two genera, *Lepidomysis* Clarke (1961) with one species, *L. servata* (Fage, 1924) and *Speleomysis* Caroli (1924) with two species, *S. bottazzii* Caroli (1924) and *S. quinterensis* (Villalobos, 1951). The new genus, *Keralomysis*, differs from both *Lepidomysis* and *Speleomysis* in the single-eye plate, long eighth thoracic limb and the completely spiny border of the telson. *Keralomysis* may be defined thus: Body dorso-ventrally flattened. Anterior border of carapace evenly concave, posterior deeply concave, cervical sulcus absent. Eyes reduced to a single-eye plate without visual elements. Abdominal segments with pleural plates (?) and ventral chitinous lamellae. Telson entire, its margin spiny throughout. Basal segment of antennular peduncle with outer distal process, distal segment with inner distal spine. Antennal scale short, with fully setose border. Left mandible with lacinia mobilis, right with modified spines. Maxillule with two-segmented palp carrying a long sparsely pectinate seta. First thoracic appendage (maxilliped) with very small exopod and large epipod. Second thoracic appendage (gnathopod) without internal lobes. Thoracic appen-

dages three to seven subsimilar, penultimate segment not subdivided, eighth appendage much longer than seventh, with small exopod. Branchiae absent. Brood lamellae seven pairs. Pleopods biramous, exopod three-segmented (that of second four-segmented), endopod one-segmented. Exopod of uropod two-segmented, outer border of basal segment spiny, endopod without statocyst.



FIGS. 1-2. *Keralomysis longipes*, n. gen., n. sp. Fig. 1. Non-ovigerous female, dorsal view. Fig. 2. Ovigerous female, lateral view.

Male slightly smaller than female. Third segment of antennular peduncle with distal median lobe. Thoracic appendages three to five with bunches of pectinate setae. Exopod of pleopod two three-segmented, second segment stout.

Type species: *Keralomysis longipes* n. gen., n. sp. Type locality: Kottayam (Kerala-India).

Lepidomysids are now known from only four localities, Kerala (India), Zanzibar (Africa), Otranto (Italy) and Tamaulips (Mexico). Their distribution is thus discontinuous and has great zoogeographical significance.

A full account of the species will be published elsewhere.

Marine Biol. Laboratory, N. KRISHNA PILLAI.  
University of Kerala, T. MARIAMMA.  
Trivandrum-7,  
February 13, 1963.

1. Caroli, E., *Atti. R. Acad. Naz. Lincei*, 1924, **33**, 512.
2. —, *Boll. Zool. Torino*, 1937, **8**, 219.
3. Clarke, W. D., *Crustaceana*, **2**, 251.
4. Ekman, S., *Zoogeography of the Sea*, Sidgwick and Jackson, London, 1953.
5. Fage, L., *C.R. Acad. Sci., Paris*, 1924, **178**, 2127.
6. Villalobos, A., *An. Inst. Biol., Mexico*, 1951, **22**, 191.

**OBSERVATIONS ON THE  
PIGMENTATION OF PALLISENTIS SP.  
(PALLISENTIDAE: ACANTHO-  
CEPHALA), AN INTESTINAL PARASITE  
OF THE FISH OPHIOCEPHALUS**

Two orange-coloured specimens of *Pallisentis* sp. were recovered from the intestine of the fish *Ophiocephalus*. Microscopic examination of the live specimens indicated that the whole body of the worms was involved in pigmentation and that the pigment granules were unevenly distributed in the body wall. An attempt has been made to study the chemical nature of the pigments responsible for coloration of these worms. Desiccator-dried worms were cut into small pieces and the latter were subjected to various histochemical tests. The pigments have been found to be soluble in such solvents as chloroform, 70% ethyl alcohol, acetone, xylol, etc., and insoluble in water, 10% formalin, and weak acids and alkalis. The parasites appeared to lose coloration on exposure to atmospheric air suggesting autoxidation of the pigments. Furthermore, the pigments showed a fairly strong greenish-blue coloration on treatment with concentrated sulphuric acid. These properties of the present biochrome (such as solubility in organic solvents, color reaction, autoxidation, etc.), seem to suggest that they are carotenoids (Fox, 1953). It is not known whether the pigments involved in the coloration of these spiny-headed worms are a mixture of chemically distinctive compounds or simply a single compound like  $\beta$ -carotene. Extraction, chromatographic separation and subsequent spectrophotometric absorption analysis of the pigments could not be carried out because of insufficiency of material.

The occurrence of carotenoid pigments has already been demonstrated histochemically in an acanthocephalan *Arhythmorhynchus comptus* (Van Cleave and Rausch, 1950), and by spectrophotometric absorption analyses and other

methods in a few larval trematodes (Nadakal, 1960 a). It is known that animal organisms are not able to synthesize carotenoid pigments *de novo* in their bodies; they are absorbed and accumulated in tissues from dietary sources in a metabolically altered or unaltered condition (Fox, 1953; Goodwin, 1954; Nadakal, 1960 a). It is possible that the carotenoid coloration of these parasites results from the uptake of coloured food materials ingested by the fish hosts.

One remarkable phenomenon noticed in connection with the pigmentation of these worms is that among several specimens recovered from the intestine of the fish, only two have been found to be coloured. Such intraspecific and interspecific variations in pigmentation have been recorded in other parasitic species like larval trematodes occurring in the marine snail *Cerithidea californica* (Nadakal, 1960 a, b), spiny-headed worms (Meyer, 1933) and tetra-rhynchid tapeworms (Dollfus, 1942) found in fishes. To the present author's knowledge no adequate explanation has been offered to account for this interesting but intriguing phenomenon. It may be suggested, however, that such differences might reflect some genetic or anatomical or enzymic factors leading to differential metabolism of these parasites favouring an incidental accumulation of pigments.

Mar Ivanios College, A. M. NADAKAL.  
Trivandrum, October 27, 1962.

1. Dollfus, R., *Arch. Mus. National D'Hist. Natur.*, 1942, **19**, 1.
2. Fox, D. L., *Animal Biochromes and Structural Colours*, Cambridge University Press, 1953, p. 63.
3. Goodwin, T. W., *Carotenoids. Their Comparative Biochemistry*, Chemical Publishing Company, New York, 1954.
4. Meyer, A., In: *Bronn's Klassen und Ordnungen des Tierreiches*, Akademische. Verlagsgesellschaft, Leipzig, 1933, **4** (2), Book 2.
5. Nadakal, A. M., *Jour. Parasit.*, 1960 a, **46**, 777.
6. —, *Biol. Bull.*, 1960 b, **19**, 98.
7. Van Cleave, H. J. and Rausch, R. L., *Jour. Parasit.*, 1950, **36**, 278.

**AN INSTANCE OF IMPERMEABILITY  
TO COLOUR PIGMENTS AT SILK  
GLAND LEVEL IN A POLYVOLTINE  
STRAIN OF BOMBYX MORI L.**

THE common cocoon colours met with in the indigenous races of *Bombyx mori* L. are yellow, green and white in their various shades and usually the colour of cocoon corresponds to the colour of hæmolymp. It has been shown by Hatamura and Harizuka (1944), that the colour pigments carotenoids found in cocoons

are derived from the mulberry leaves. The relationship between genetic control and cell permeability to colour pigments in cocoons has been worked out by Jucci (1932, 1949), Jucci and Manunta (1932), Goldschmidt and Katsuki

6. Colour and form of the cocoon: White oblong with one end roundish and another slightly pointed.

The rearing data for the new strain bred over six generations are given in Table I.

TABLE I

Sl. No.	Season	Colour of eggs	Cocoon colour	Hatchability %	Sterility %	Larval period in days	Cocoon wt. (g.)	Siik ratio %	Wt. of 10 mature worms (g.)
1	March, 1962	.. Deep yellow	White	74.6	0.5	25	0.68	14.6	17.5
2	April-May, 1962	.. do.	do.	25.3	*61.9	23	0.80	15.6	17.1
3	May-June, 1962	.. do.	do.	70.5	2.1	21	0.65	13.9	16.0
4	July, 1962	.. do.	do.	77.6	11.5	22	0.88	15.8	17.1
5	Aug-Sept., 1962	.. do.	do.	92.3	5.3	23	0.95	15.0	24.1
6	Sept-Oct., 1962	.. do.	do.	89.8	4.8	22	0.88	14.6	17.1

\* Due to high temperature higher sterility was obtained.

(1931), Katsuki (1935), Harizuka (1940 and 1948) and Fujimoto (1949 *a* and 1949 *b*). Work on this aspect has been reviewed by Kikawa (1953) and according to him the formation of yellow cocoons is believed to be controlled at least by 3 genes, viz., A (unknown chromosome), Y (25.6 in the II chromosome) and yc (0.0 in the XII chromosome). Of the various phenotypic combinations, the type A, Y, yc is responsible for the yellow colour of the haemolymph but with white cocoon colour. Such a combination is very rare and only one case has so far been cited in the univoltine races by Yokoyama (1959).

In polyvoltine races a similar type A, Y, yc with yellow haemolymph and white cocoon has been isolated for the first time from the hybrid race N 124, C 109 × Nistari. This strain is completely recessive for cocoon colour as revealed by results with the following crosses.

New strain (white cocoon) × Biorace (yellow cocoon) and reciprocal cross: All yellow cocoons. New strain (white cocoon) × Nismo yellow (yellow cocoon) and reciprocal cross: All yellow cocoons.

This new strain is breeding true over about 6 generations and their morphological characteristics are as follows:

1. Egg colour: Very deep yellow (normal colour being light creamy yellow).
2. Larval pattern: Marked with mask on the head, lunules on the 2nd segment and circular patches on fifth abdominal segments.
3. Colour of larva: Deep orange yellow resembling that of grasserie infected worms.
4. Colour of pupa: Deep brown (deeper than the usual pupa colour).
5. Colour of moth: Creamy yellow wing and abdominal scales.

The authors express their thanks to Mr. P. B. Sinha for his help in the rearing work.

Central Sericultural Research Station,  
Berhampore (W. Bengal),  
November 17, 1962.

M. S. JOLLY.

S. KRISHNASWAMI.

1. Fujimoto, N., *J. Seric. Sci. Japan*, 1949 *a*, 18, 73.
2. —, *Ibid.*, 1949 *b*, 18, 215.
3. Goldschmidt, R. and Katsuki, K., *Biol. Zbl.*, 1931, 51, 58.
4. Harizuka, M., *J. Seric. Sci. Japan*, 1940, 11, 267.
5. —, *Ibid.*, 1948, 17, 1.
6. Hatamura, M. and Harizuka, M., *J. Genet.*, 1944, 20, 89.
7. Jucci, C., *Proc. 6th Int. Congr. Genet.*, 1932, 1, 377.
8. —, *Proc. 8th int. Congr. Genet.*, 1949, p. 286.
9. —, and Manunta, C., *R. C. Accad. Lincei*, 1932, 15, 473.
10. Katsuki, K., *Biol. Zbl.*, 1935, 55, 361.
11. Kikkawa, H., *Advances in Genetics*, 1953, 5, 107.
12. Yokoyama T., *Silkworm Genetics Illustrated*, 1959, p. 17.

## COLLATERAL HOST PLANTS OF ROOT-KNOT NEMATODES

THE root-knot nematodes *Meloidogyne javanica* (Treub.) Chitwood, and *Meloidogyne incognita* (Kofoid and White) Chitwood, have been reported by Pushkarnath *et al.* (1958) and Nirula (1958, 1961) as causing serious damage to potatoes in India. They are also known to cause heavy damage to other tuber crops and a large number of vegetable crops.

Goodey and Franklin (1956) have given an exhaustive list of the host plants of *Meloidogyne* spp. Recently Martin (1959) also added a number of new host plants to this list.

A study of the collateral host plants of *Meloidogyne* spp. was initiated at the Central

TABLE I

New host plants of *Meloidogyne* spp.

Sl. No.	Host Plant	Locality	First appearance	Nature of attack
<i>M. javanica</i>				
1	<i>Acalypha (indica)</i> L.	Patna	July, 1962	Mild infestation on roots
2	<i>Cassia tora</i> L.	"	Sept., 1962	"
3	<i>Cestrum nocturnum</i> L.	"	Aug., 1962	"
4	<i>Chenopodium album</i> L.	"	March, 1962	"
5	<i>Cleome viscosa</i> L.	"	July, 1962	Light infestation on roots
6	<i>Celcus parviflorus</i> Benth.	"	Sept. 1958	Severe infestation on tubers and roots
7	<i>Croton sparsiflorum</i>	"	" 1962	Light infestation on roots
8	<i>Curcuma longa</i> L.	"	Feb., 1959	Very severe infestation on rhizomes
9	<i>Digera arcensis</i> Forsk	"	Aug., 1962	Light infestation on roots
10	<i>Hibiscus asinensis</i> L.	"	July, 1962	Mild infestation on roots
11	<i>Luffa acutangula</i> Roxb	"	Aug., 1958	Severe infestation on roots
12	<i>Luffa cylindrica</i> M. Roem	"	"	"
13	<i>Manihot utilisim</i> Pohl	"	Sept., 1958	Light infestation on roots
14	<i>Anthosacra brachiata</i>	"	Aug., 1962	Mild infestation on roots
15	<i>Rubus idaeus</i> L.	"	Feb., 1961	Light infestation on roots
<i>M. incognita</i>				
16	<i>Stellaria media</i> L.	Patna	July, 1962	Mild infestation on roots
17	<i>Calendula officinalis</i> L.	Simla	"	Heavy infestation on roots
18	<i>Chenopodium album</i> L.	"	"	Mild infestation on roots
19	<i>Rumex nepalensis</i> Spreng.	"	"	"
20	<i>Scabiosa purpurea</i> L.	"	"	"
21	<i>Zinnia elegans</i> Jacq.	"	Aug., 1962	"

Potato Research Institute in 1958. The survey revealed twenty-one new host plants, hitherto unrecorded in literature (Table I).

Grateful thanks are due to Dr. Pushkarnath, Director, for his kind encouragement and interest in this work. Thanks are also due to Drs. Mary T. Franklin and J. B. Goodey of Rothamsted Experimental Station, Harpenden, U.K., for confirming some of the identifications and for checking up the list of the host plants of *Meloidogyne* spp.

Central Potato Research  
Institute, Simla.  
October 22, 1962.

K. K. NIRULA.  
RABINDER KUMAR.

1. Pushkarnath and Roychaudhri, B. N., "Root-knot nematodes on potato in India," *Curr. Sci.*, 1958, 27, 214.
2. Nirula, K. K., "Root-knot nematodes on potato," *Proc. Ent. Res. Workers Conf.*, 1958.
3. —, "Control of root-knot nematode," *Indian Potato J.*, 1961, 3, 72.
4. Goodey, J. B. and Franklin, M. T., "The nematode parasites of plants catalogued under their hosts," *Commonw. Agric. Bur. Farnham. Royal, Bucks, England*, 1956.
5. Martin, G. C., "Plants attacked by root-knot nematodes," *Rhod. Agric. J.*, 1959, 56, 162.

### KNEEING HABIT IN RICE

Local Aryan is a medium-duration first crop variety of rice cultivated in the low-lying lateritic areas of Kerala State. The outstanding feature of this variety is its 'kneeing' habit. Being a first crop variety, it has to withstand

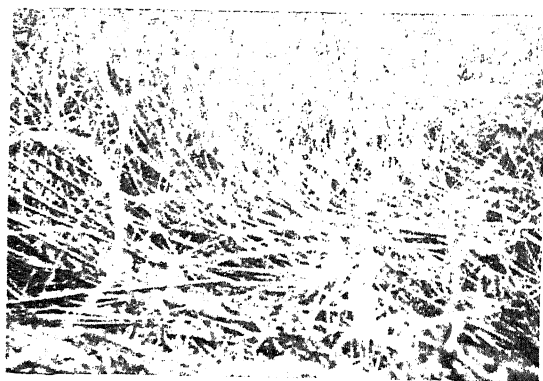


FIG. 1

heavy rains and as it is a tall variety, it lodges. 'Kneeing' is the adaptation to overcome this natural adversity. Under the pressure of wind and rain, the variety lodges during the vegetative phase itself during June to July, when it will

be 3-4 months old. After lodging the growth continues not horizontally but upwards so that the plant cuts one or two more nodes before ear-production, and ears are held up on these erect stalks of one or two nodes. The internodes of these erect stalks are very long. Thus the plant does not fall flat or submerge under water. This is a remarkable, economically useful, instance of adaptation in cultivated rice to the lodging caused by heavy rains during the first crop season (April-August).

The average height of the variety is 163 cm. the lengths of the 'kneed' portion and erect portion from samples are given separately for comparison (Table I). The variety takes 145

TABLE I

Length of 'kneed' portion (cm.)	Length of erect portion (cm.)	Total length cm.
78	88	166
96	66	162
87	83	170

days to mature. Rice is coarse and red. Average yield is 3,700 kg./hec.

Rice Research Station, P. K. NARAYANAN.  
Mannuthi (Trichur), M. P. BALAKRISHNAN.  
November 21, 1962.

#### HYDROCYANIC ACID CONTENT OF DISEASED AND HEALTHY PLANT PARTS OF SORGHUM

LEAVES AND STEM of sorghum (*Sorghum vulgare* Pers.) are known to contain hydrocyanic acid (HCN)<sup>1</sup> and HCN is toxic to micro-organisms even in low concentrations.<sup>2</sup> Several bacterial and fungal diseases are known to attack the leaves and stem of sorghum. With a view to compare the HCN concentrations of the diseased and healthy leaves and stems of sorghum studies were made and the results are briefly reported here.

Fresh specimens of sorghum leaves affected by leaf-stripe caused by *Helminthosporium turcicum* Pass. and of stem affected by top-rot caused by *Fusarium moniliforme* Scheld., were collected from the field. Specimens of healthy leaves and stems of approximately same age were also collected from healthy plants, from identical positions on the plants from the same field. The tissues were cut into small bits, collected in a polythene bag and incubated in a frigidaire at 5-8° C. for 24 hours. The freeze-dried samples were then taken up for estimating the HCN content, following the procedure described by Hogg and Ahlgren.<sup>3</sup> In all three sets of samples from diseased and healthy plants were

analysed and the average data are given in Table I.

TABLE I

HCN content of diseased and healthy parts  
of sorghum  
(HCN in mg./100 g. on dry wt. basis)

Plant part	Healthy	Diseased
Leaf ..	21	0
Stem ..	82	8

In the diseased leaf there was no HCN whereas in the top-rot affected stem the HCN had been reduced to a considerable extent, leaving only a trace. These results indicate that the physiological condition of diseased plant is so changed that it greatly affects the HCN content of tissues. Cornoldi<sup>4</sup> reported that in sorgho plants affected by 'yellows' disease or by aphids there was relatively low concentration of HCN and the results obtained in the present studies in respect of other diseases of sorghum greatly agree with his report. The HCN in leaf and stem, as estimated in the present studies, works out to 210 p.p.m. and 820 p.p.m. on dry weight basis. In the *in vitro* studies it was found that in potato dextrose agar medium the cyanide when used as KCN at 100 to 200 p.p.m. was inhibitory to most bacteria and fungi including *Helminthosporium* spp. and *Fusarium* spp. According to Trione 135 p.p.m. of HCN was inhibitory to *F. moniliforme* var. *lini* (Bolley) Snyder and Hans., the flax wilt fungus. Thus it is evident that the healthy leaves and stem contain concentrations of HCN inhibitory to micro-organisms, but the mechanism with which the pathogens are able to infect and establish themselves in the tissues is not understood. Carlson<sup>5</sup> stated that low HCN in sorghum varieties is correlated with susceptibility to *H. turcicum* but this needs further verification in view of the fact the pathogen is capable of establishing itself even when inhibitory concentrations of HCN are present in the tissues.

Department of Agri., A. BALASUBRAMANIAN.  
Annamalai University, G. RANGASWAMI.  
Annamalainagar,  
November 23, 1962.

1. Acharya, C. N., *Indian J. Agric. Sci.*, 1933, 3, 851.
2. Trione, E. J., *Phytopathology*, 1960, 50, 482.
3. Hogg, P. G. and Ahlgren, H. L., *J. Agric. Res.*, 1943, 67, 195.
4. Cornoldi, G., *Ind. Sacc. Ital.*, 1939, 32, 145.
5. Carlson, I. T., *Agron. J.*, 1958, 50, 302.

## NEW RECORDS OF FUNGI FROM MYSORE

### II. Some Entomogenous Fungi

In this note, an account of some entomogenous fungi collected at the Coffee Research Station, Balehonnur, is presented. The specimens have been deposited in the Herbarium Cryptogamiæ Indiæ Orientalis, Indian Agricultural Research Institute, New Delhi, and their accession numbers are indicated in parentheses. These are new records for India.

#### *Metarrhizium* Sp.

Sporodochia superficial, discoid-scutellate, brownish in the centre with white margins, somewhat convoluted, 100–250  $\mu$  high and 200–750  $\mu$  diam.; conidiophores arising from a basal stroma of interwoven, hyaline hyphae and forming a regular palisade layer, branched; phialides cylindrical, attenuated above into slender sterigmata. 3.5–7  $\mu$  long, 8.5–15.5  $\times$  1–2.5  $\mu$ ; conidia globose, 1.5–2  $\mu$  diam., or ovate, 1.5–2  $\times$  1–1.5  $\mu$ , hyaline, continuous, catenulate.

Hab. On an ant, Coffee Research Station, Balehonnur, 14-1-1962, T. R. Nag Raj (H.C.I.O. 27624) [Fig. 1 (2, 3)].

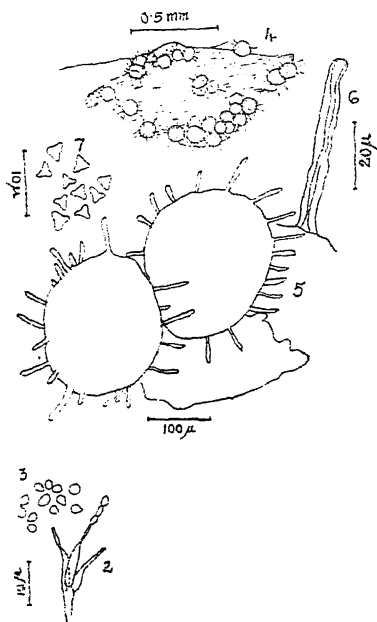


FIG. 1. (2-3) *Metarrhizium* sp. Phialides and conidia. (4-7) *Muricularia eurotioides*. (4) Pycnidia developing on the host. (5). Enlarged view of pycnidia. (6) A seta from the pycnidial wall. (7) Conidia.

The ant's body is covered by a thin film of greyish to brown mycelium by which the insect is firmly attached to the substratum. The

sporodochia occur usually at the joints of the body. When wet the spore mass is cream yellow in colour and brown when dry. This collection appears to differ from the known species of *Metarrhizium*, but needs to be compared with authentic specimen of *M. brunneum* and *M. alba*, with which it seems to have a closer affinity, before a name could be applied to it.

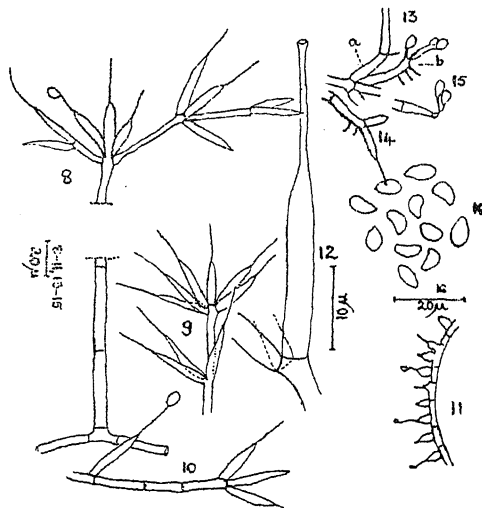


FIG. 2. (8-10) *Verticillium fuliginosum*. (8-10) Conidiophores. (11) Phialides on repent hyphae. (12) Enlarged view of a phialide. (13a and 14) Phialides giving rise to secondary conidiophore and secondary phialides. (13b and 15) Multiple sterigmata on phialides. (16) Conidia.

#### *Muricularia eurotioides* SACC. IN *Michelia* I, p. 95

Pycnidia superficial, at the margin or all over a thin, black stroma covering the insect, clustered or scattered, black, globose to ovate, 112–252  $\times$  112–224  $\mu$ ; wall covered with numerous, erect, black, thick-walled, non-septate setae 19–68  $\times$  5–6.5  $\mu$ ; pycnidiospores triangular, with rounded angles and concave sides, 2  $\mu$  along each side.

Hab. on undetermined scale insects on *Jasminum sambac* Ait., Coffee Research Station, Balehonnur, 29-5-1962, T. R. Nag Raj (H.C.I.O. 27623) [Fig. 1 (4-7)].

#### *Verticillium fuliginosum* PETCH IN *Trans.* *Brit. Mycol. Soc.*, 1934, 19, p. 186

Mycelium covering the insect and spreading over the leaf in a byssoid film, white at first then fuliginous; hyphae 5  $\mu$  diam., septate, hyaline to pale fuscous, with black patches occurring on the cell wall at or away from the septa; conidiophores erect, septate, smooth, pale fuscous below, hyaline above, 630–730  $\mu$  high,

8-9  $\mu$  broad at the base, gradually attenuated towards the top, thick-walled, bearing one or two whorls of phialides towards the apex; phialides 2-5 in a whorl, cylindrical, gradually tapering towards the apex and terminating in a slender sterigma up to 26  $\mu$  long, unicellular, 25-57  $\times$  3-6  $\mu$ ; conidia hyaline, unicellular, broadly cymbiform or oval, 8-9.5  $\times$  5.5-6.5  $\mu$ , in mucus.

Hab. On a leaf-hopper on *Premna tomentosa*, Coffee Research Station, Balehonnur, 14-1-1962, T. R. Nag Raj (H.C.I.O. 27622) [Fig. 2 (8-16)].

Petch (*loc. cit.*) described the phialides as one-septate, but, in the present collection, mature phialides were always continuous. On old conidiophores, however, phialides giving rise to secondary phialides [Fig. 2 (14)], or bearing two or more sterigmata [Fig. 2 (15)] were sometimes one-septate. Old phialides were also observed to give rise to secondary conidiophores [Fig. 2 (13a)]. The young phialides normally bear a single sterigma, which is terminal; but, on old phialides sterigmata, when more than one in number, are both terminal and lateral [Fig. 2 (13b)]. Phialides may also arise directly on repent hyphae [Fig. 2 (11)]. These are usually unicellular, but occasionally one-septate, 6.5-14.5  $\times$  5-6.5  $\mu$  with one or two slender sterigmata, 5-13  $\mu$  long.

The writer is grateful to Sri. K. V. George, Mycologist, and Dr. N. G. Chokkanna, Director of Research, for laboratory facilities and permission to publish this note.

Coffee Res. Station P.O., T. R. NAG RAJ.  
Balehonnur, Mysore State,  
November 13, 1962.

### TASTE DEFICIENCY IN A STUDENT POPULATION OF HYDERABAD, ANDHRA PRADESH

THE ability to taste phenyl-thio-carbamide, a very bitter substance, has been shown to be inherited by Snyder,<sup>1</sup> Blakeslee and Salmon<sup>2</sup> as a single dominant, the genotypes of the tasters being TT and Tt, whereas non-tasters are homozygous for the recessive allele t. Blakeslee and Fox<sup>3</sup> determined that 70% of the North American Whites are tasters and 30% are non-tasters. According to the data compiled by Rife<sup>4</sup> the frequency of tasters ranges from only 63% among Arabs to 93 and 96% in the Chinese and in pure Nilotic Negroes respectively.

Similar studies have not been made extensively in Indian populations. The author, taking advantage of a science exhibition organized

recently at Osmania University College of Science, tested 2,428 persons for taste-blindness to PTC. Filter-paper soaked in distilled water solution of 40 mgm./litre and cut into thin strips were given for tasting. Some experienced an intensively bitter taste and others no taste at all. There were no doubtful cases. Of the 2,428 persons tested 1,536 were tasters and 892 non-tasters.

Since no tendency exists towards assortive mating with regard to taste deficiency the population can be treated as a panmictic one and the data analyzed by applying Hardy-Weinburg law. This law which applies to population genetics and is a corollary to mendelian inheritance was formulated independently by Hardy<sup>5</sup> and Weinburg.<sup>6</sup> It states that populations may have any proportions of dominant and recessive characters and the relative frequencies of each gene allele tend to remain constant generation after generation in the absence of forces that change gene frequencies, such as mutation, selection and migration.

The solution of the Hardy-Weinburg formula

$$q^2 TT : 2q(1-q) Tt : (1-q)^2 tt$$

where q and (1-q) are the frequencies for T and t alleles respectively, gives 60.6% as the frequency of t, the non-taster allele and 39.4% as the frequency of T, the taster allele. The frequencies of the homozygous tasters, TT and the heterozygous tasters, Tt, in the population are 15.52 and 47.75% respectively. The non-tasters tt constitute 36.73% of the population.

The data are limited in scope. A thorough study is required to arrive at general conclusions about the gene frequencies of T and t alleles in the different populations of Hyderabad.

The author wishes to thank Prof. N. V. Subba Rao, Principal of Science College, for the kind permission to carry out this investigation and Prof. M. R. Suxena for valuable advice.

Botany Department, M. HASHIM.  
Osmania University,  
Hyderabad-7, A.P., January 14, 1963.

1. Snyder, L. H., *Ohio J. Sci.*, 1932, **32**, 436.
2. Blakeslee, A. F. and Fox, A. L., *J. Hered.*, 1932, **23**, 96.
3. — and Salmon, M. R., *Eugen News*, 1931, **16**, 105.
4. Rife, D. C., *Dice of Destiny*, 2nd Ed., Long's College Book Co., 1947.
5. Hardy, G. H., *Science*, 1908, **28**, 46.
6. Weinburg, W., *Jahreshefte Verein f. vaterl. Naturk. in Wurttemberg*, 1908, **64**, 368.

# FUNGI-TOXICITY OF EXTRACTS FROM TANNIN-BEARING PLANTS

TANNINS are known to possess antibacterial and virucidal properties. Extracts of several tannin-bearing plants have been reported as effective antibacterial and virucidal agents.<sup>1-4</sup> Certain tannin-bearing plants are believed to have piscicidal properties and are also used in the preservation of fishing nets.<sup>5</sup> However, studies on fungi-toxicity of vegetable tannins do not

American Phytopathological Society,<sup>7</sup> modified by Horsfall and Rich.<sup>8</sup> Slides were incubated at a constant temperature of 30° C. for a period of 24 and 36 hours respectively for *P. oryzae* and *C. falcatum* to allow complete germination of conidia. Extracts from two non-tannin bearing plants were also included in the test for comparison. Each concentration of the extract and check (distilled water) was replicated three times. The data are presented in Table I.

TABLE I

Germination percentage of conidia in various concentrations of the test material (average of 3 replications)

Plant	Tannin-bearing part	Concentration (in gm. per litre)									
		<i>P. oryzae</i>					<i>C. falcatum</i>				
		10.0	1.0	0.1	0.01	Check	10.0	1.0	0.1	0.01	Check
<i>Acacia arabica</i> Willd.	.. Bark	Nil	Nil	56.4	58.7	72.6	10.8	21.5	26.0	76.5	71.0
<i>Acacia catechu</i> Willd.	.. Heart wood	Nil	52.4	90.8	94.9	96.4	Nil	3.7	24.4	29.5	38.1
<i>Arca catechu</i> Linn.	.. Fruit	Nil	1.0	89.0	94.1	91.2	2.8	41.9	55.2	62.9	58.5
<i>Carissa opaca</i> Stapf.	.. Leaf	Nil	50.7	89.3	92.9	93.5	2.0	26.5	27.2	47.0	50.1
<i>Cassia fistula</i> Linn.	.. Bark	Nil	Nil	92.0	97.6	97.0	Nil	14.3	79.5	74.7	75.0
<i>Cassia tora</i> Linn.	.. Stem	Nil	42.1	89.0	88.9	93.2	Nil	13.5	58.7	58.8	63.3
<i>Emblia officinalis</i> Gaertn.	.. Fruit	Nil	39.1	68.4	83.0	96.2	1.7	16.7	27.8	28.9	36.6
<i>Geranium nepalense</i> Sweet.	.. Root	Nil	25.0	98.5	96.2	94.7	9.2	24.0	36.1	35.9	42.5
<i>Punica granatum</i> Linn.	.. Pind	2.8	64.6	75.9	68.1	77.3	33.3	30.3	77.3	84.7	78.6
<i>Syzygium cumini</i> (L.) Skeels.	.. Bark	Nil	24.0	92.1	93.2	87.3	6.2	18.0	32.3	51.7	56.8
<i>Terminalia arjuna</i> W. and A.	.. Bark	Nil	10.1	60.6	75.0	84.1	3.6	21.8	37.5	50.0	59.5
<i>Terminalia bellerica</i> Roxb.	.. Fruit	Nil	18.8	40.7	68.5	90.5	9.5	32.7	49.4	66.9	60.7
<i>Terminalia chebula</i> Retz.	.. Fruit	Nil	41.4	84.1	97.0	95.4	26.8	28.7	43.4	42.2	44.1
* <i>Cannabis sativa</i> Linn.	.. ..	92.5	93.5	94.1	94.3	95.0	32.9	32.7	28.4	31.3	43.4
* <i>Lantana camara</i> Linn.	.. ..	92.6	99.4	81.7	100.0	90.9	92.3	90.6	93.3	97.9	94.9

\* non-tannin-bearing plants.

appear to have been reported, although some recent reports from Russia<sup>6</sup> have indicated that a naturally occurring plant polyphenolic acid like chlorogenic acid and its polymeric forms may contribute to the resistance of certain varieties of potato to potato blight (*Phytophthora infestans* de Bary). The work reported here was undertaken to determine the fungi-toxicity of extracts from 13 tannin-bearing plants, using *Piricularia oryzae* Cav. and *Colletotrichum falcatum* Went (*Phylospora tucumanensis* Speg.), the respective causal agents of blast of rice and red-rot of sugarcane, as the test organisms.

Fifty gm. of air-dried tannin-bearing part of each plant was extracted with acetone in a soxhlet apparatus. The solvent was recovered under reduced pressure and the material oven dried at 95°-100° C. and powdered. Conidial germination of *P. oryzae* and *C. falcatum* in 10.0, 1.0, 0.1 and 0.01 gm. of the powdered material per litre of distilled water was tested using the 'slide germination' method of the

It is evident from the data that extracts of all the tannin-bearing plants tested, have shown positive inhibition of the conidial germination of both the fungi, especially at the concentration of 10.0 gm./litre and to a lesser extent but also appreciably at the concentration of 1.0 gm./litre. Extracts from *Acacia arabica*, *Emblia officinalis*, *Terminalia arjuna* and *Terminalia bellerica* tended to be toxic at the concentration of 0.1 gm./litre also. Compared between the two fungi, toxicity to *P. oryzae* appeared to be more marked. Extracts from two non-tannin-bearing plants had no toxic effect on any of the two test fungi.

The writers are thankful to the Director, Central Rice Research Institute, Cuttack and the Head of the Division of Mycology and Plant Pathology, Indian Agricultural Research Institute, New Delhi, for supplying cultures of the test fungi and to Dr. I. C. Chopra, Deputy Director, Regional Research Laboratory, Jammu, and Dr. B. N. Mitra, Director, Regional Research



Laboratory, Jorhat, Assam, for their keen interest.

Regional Research K. K. JANARDHANAN.

Laboratory, Jammu. D. GANGULY.

and

Regional Research Lab., \*J. N. BARUAH.

Jorhat, Assam, \*P. R. RAO.

November 7, 1962.

\* Now working at the Regional Research Laboratory, Jammu.

1. Fischer, G., Gandel, S. and Jorpes, E., *Zent. Bak-teriol. Parasitenz.*, Orig., 1954, **161** (1), 349., Through *C.A.*, 1955, **49**, 3308.
2. —, and — *Experimentia*, 1954, **10**, 329.
3. Yossii, H., Tominaga, Y. and Morioka, T., *Ann. Phytopathol. Soc. Japan*, 1955, **19**, 25.
4. Tsuchihira K. and Ito M. Igaku to *Seibustragku*, 1951, **19**, 294. Through *C.A.*, **45**, 10303.
5. Chopra, R. N., Chopra, I. C., Handa, K. L. and Kapur, L. D., *Indigenous Drugs of India*, U.N. Dhur & Sons, Calcutta, 1958.
6. Sokolova, B. E., Save'ieva, O. H. and Rubin, B. A., *C. R. Acad., U.R.S.S.*, (Through Chromatographic and Electrophoretic Techniques, Vol. 1 (Inter-Science Publishers, Inc., U.S.A.), 1960, **123**, 335.
7. American Phytopathological Society, *Phytopath.*, 1943, **33**, 627.
8. Horsfall, J. G. and Rich, S., *Indian Phytopath.*, 1953, **6**, 1.

### VASCULAR ANATOMY OF THE FLOWER OF *LIMEUM INDICUM* STOCKS

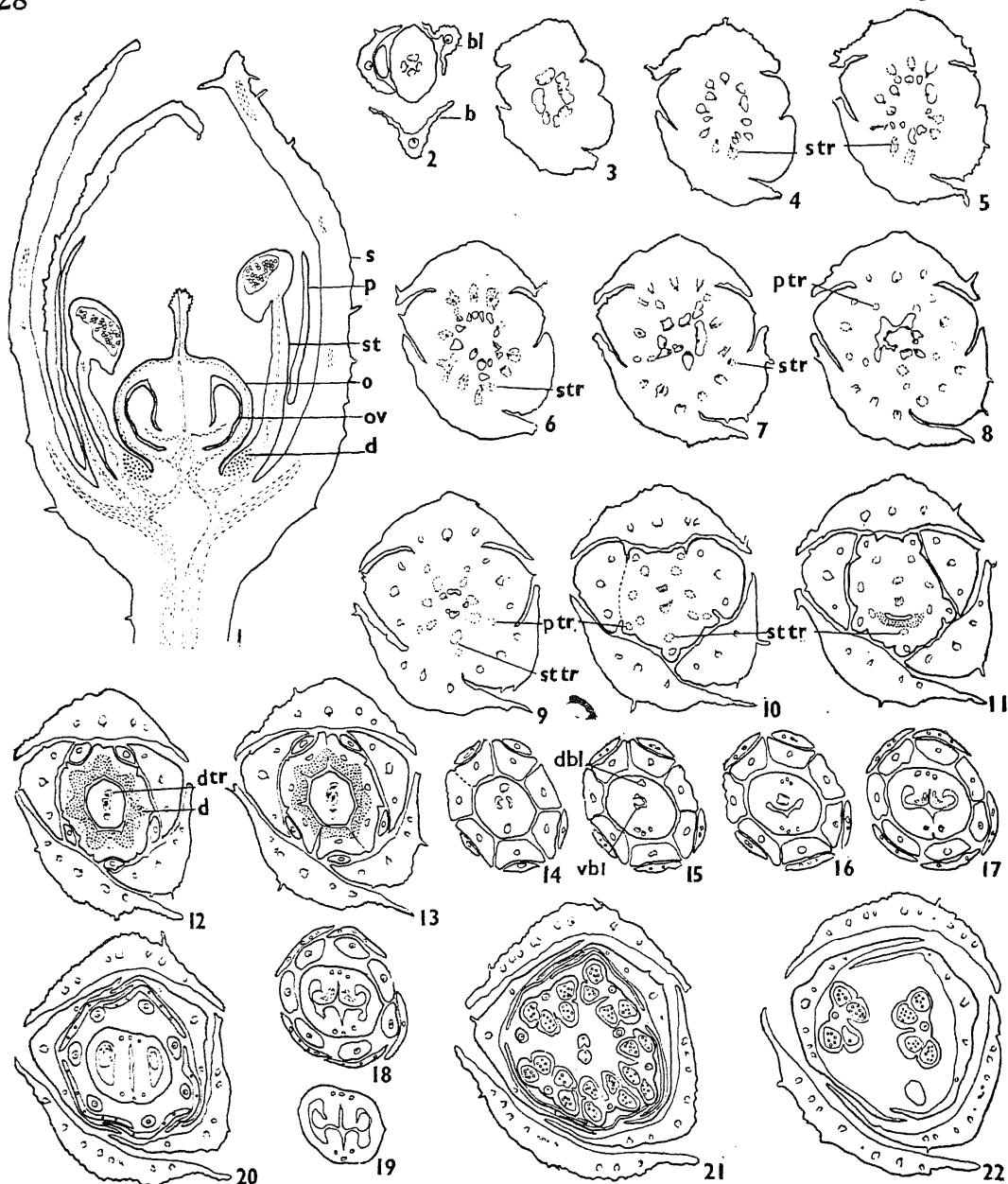
PREVIOUS work (Saunders, 1930; Joshi and Rao, 1933) on the floral anatomy of some members of the Phytolaccaceae related either for supporting or refuting the theory of carpel polymorphism. The present study on *Limeum indicum* clarifies some important points on the nature of the petals, nectariferous disc, number of staminal whorls and gynoecium.

The pedicel shows a ring of four conjoint collateral bundles (Fig. 2). The anterior outer sepal is the first to differentiate followed by the posterior outer sepal, the anterior imbricate sepal, and the two lateral inner sepals in a sequence (Figs. 3-11). Each sepal is traversed by a median trace and two marginals which are contributed by the division of the commissural traces (Fig. 6). As the sepal traces depart, the stele organises five petal traces (Figs. 8-10). These are soon followed by the delimitation of seven staminal traces, of which five are in line with those of the petals and the remaining two which are slightly belated in origin, are opposite the two lateral, inner sepals (Figs. 9-11). The staminal traces enter the short tube formed by the cohesion of dilated bases of the filaments (Fig. 12). The adaxial face of this tube is glandular. At a slightly higher level this tube resolves into the component filaments each

with a vascular bundle (Figs. 13-15). Meanwhile, at the base of the ovary the central stele contributes to one dorsal each anteriorly and posteriorly. The remaining bundles form the ventrals of the two carpels with the inverse orientation (Figs. 12-15). These ventrals later fuse at the base of the ovarian chamber (Fig. 16) and supply the two ovules on the anterior side (Fig. 17). Thus the placentation is basal and only the anterior carpel functions. Concomitantly, both the dorsals branch and supply the antero-posterior regions of the ovary (Figs. 15, 16). The locule soon divides into two at a higher level by the fusion of the prolongations (false septæ) from the antero-posterior sides of the wall (Figs. 17-20). The mid-dorsal bundles of the two carpels extend into the two styles and end at the base of the stigma (Figs. 1, 21, 22).

The flower of *Limeum indicum* is hetero-chlamydeous, bisexual and complete. The quincuncial sepals receive a midrib and two marginals which are commissural in origin. There are five petals receiving one trace each. According to Gundersen (1950) only the Indian species of *Limeum* and species of *Stegnosperma* are hetero-chlamydeous. In *Stegnosperma* the five petals replace the outer whorl of stamens which alternate with the perianth segments (Rendle, 1952). However, in *Limeum* the petals are distinct from the two whorls of stamens of which the stamens of the outer whorl are opposite the petals while those of the inner whorl are represented only by the two lateral stamens which are longer than those of the outer whorl and whose traces delimit slightly late. All the stamens are united at the base to form a short tube the adaxial face of which is glandular and thus the disc is staminal and never receptacular bearing the stamens as envisaged by Gundersen (1950) and Hutchinson (1959). The gynoecium is bicarpellary, syncarpous and superior. Each carpel gets a dorsal which branches into three bundles and a ventral. Only the anterior carpel functions. The original locule becomes two by the fusion of the false septæ developed from both the sides of the carpels and encloses an ovule in each locule. The placentation is basal.

We are grateful to Dr. K. Subramanyam, Deputy Chief Botanist, Botanical Survey of India, for going through the manuscript and giving helpful suggestions and to Professor C. V. Subramanian, Head of the Department of Botany, University of Rajasthan, for encouragement and facilities.



FIGS. 1-22. Fig. 1. L.S. flowerbud showing arrangement of floral parts,  $\times 45$ . Figs. 2-22. T.S. flowerbud at different levels from base upwards. Figs. 2-13,  $\times 45$ ; Figs. 14-19,  $\times 63$ ; Figs. 20-22,  $\times 45$ . (b, bract; bl, bracteole; d, disc; dbl, dorsal bundle; dcr, dorsal trace; o, ovary; ov, ovule; p, petal; ptr, petal trace; sepal trace; s, sepal; str, sepal trace; st, stamen; sttr, staminal trace; vbl, ventral bundle.)

Department of Botany,  
University of Rajasthan,  
Jodhpur, India,  
December 19, 1962.

H. S. NARAYANA.  
KANTI JAIN.

1. Gundersen, A., *Families of Dicotyledons*, Waltham, Mass., U.S.A., 1950.
2. Hutchinson, J., *Families of Flowering Plants*, London, 1959, 1.
3. Joshi, A. C. and Rao, V. S., "Floral anatomy of *Rivina humilis* L., and the theory of carpel polymorphism," *New Phyt.*, 1933, **32**, 359.
4. Rendle, A. B., *Classification of Flowering Plants*, Cambridge, England, 1952, 2.
5. Saunders, E. R., "Illustrations of carpel polymorphism—VI," *New Phyt.*, 1930, **29**, 81.

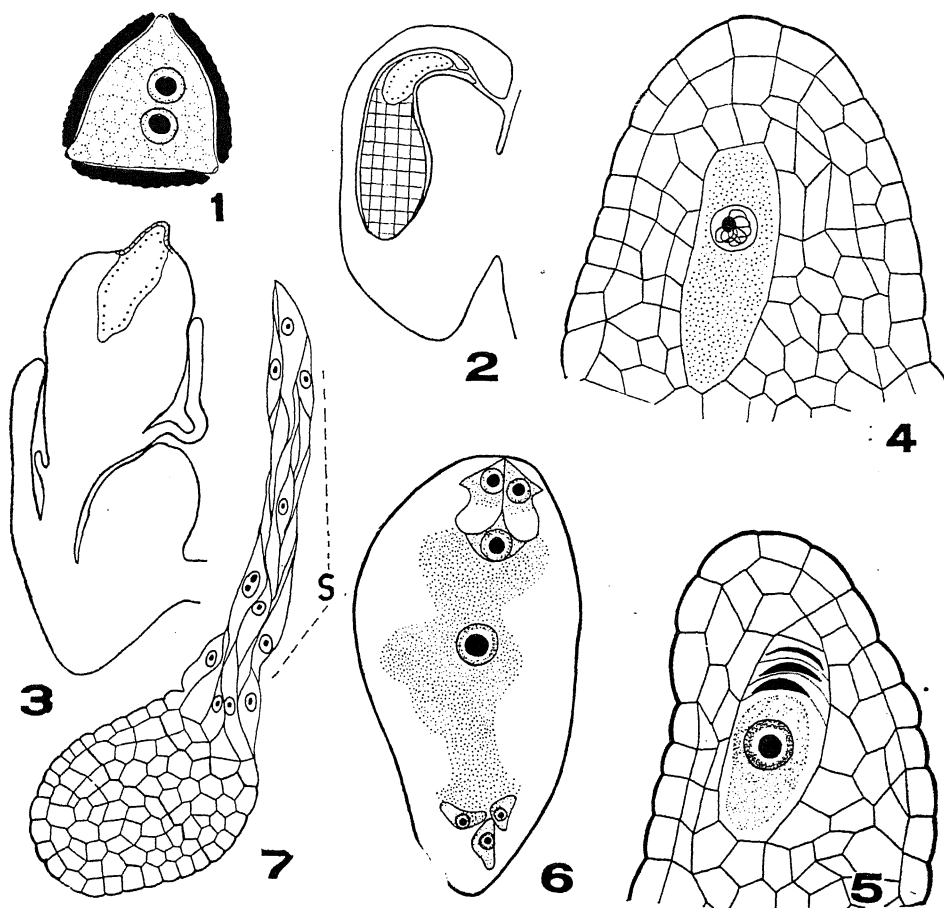
# A NOTE ON THE EMBRYOLOGY OF ERYTHRINA INDICA LAM.

THE present note deals with the development of the male and female gametophytes, endosperm and embryo of *Erythrina indica* Lam.

The floral parts arise in acropetal succession. The male archesporium consists of a hypodermal row of four to six cells. The structure of the fully formed anther shows epidermis, four layers of parietal tissue the outermost of which develops into fibrous endothecium and the innermost into secretory type of tapetum with uninucleate cells. The latter surrounds the microsporogenous tissue which is extensive. The microspore mother cells divide in a simultaneous manner and cytokinesis is by

furrowing. The pollen grains are spherical, triporate and two-celled at the time of shedding (Fig. 1).

The ovules, borne on marginal placentæ, are campylotropous, crassinucellate and bitegmic. The archesporial cell cuts off a parietal cell which by further divisions forms 2-3 cells thick parietal tissue (Fig. 4). During the further growth of the embryo-sac the parietal tissue above it becomes completely crushed and the mature embryo-sac comes to lie below the nucellar epidermis (Fig. 2). The nucellar tissue around the embryo-sac in its apical part also is similarly crushed. The outer integument is comparatively thicker than the inner and the micropyle is formed by both



FIGS. 1-7. Fig. 1. Pollen grain,  $\times 1,091$ . Fig. 2. L.s. ovule showing embryo-sac, nucellus and integuments,  $\times 50$ . Fig. 3. L.s. ovule showing proliferated nucellus and poorly developed integuments,  $\times 50$ . Fig. 4. L.s. part of ovule showing the megaspore mother cell,  $\times 625$ . Fig. 5. L.s. part of ovule showing linear tetrad of megaspores of which the chalazal is functional,  $\times 625$ . Fig. 6. Mature embryo-sac,  $\times 400$ . Fig. 7. Young embryo with suspensor(s),  $\times 160$ .

the integuments. An integumentary tapetum is differentiated later. In a low percentage of ovules the nucellus proliferates and outgrows the integuments and assumes a somewhat flattened form (Fig. 3).

The female archesporium is hypodermal and consists of three or four cells. Usually one of them only is functional and develops into the megaspore mother cell after cutting off a parietal cell. A linear tetrad of megaspores is formed as a consequence of the two meiotic divisions in it (Fig. 5). The development of the embryo-sac conforms to the Polygonum type<sup>1</sup> and the embryo-sac shows normal structure (Fig. 6). The synergids bear hooks but no filiform apparatus. The antipodals degenerate at about the time of fertilisation.

The development of the endosperm is according to the nuclear type and that of the embryo conforms to the Asterad type and keys out to the Senecio variation.<sup>2</sup> The suspensor becomes long and three or four cells thick and consists of large, more or less spindle-shaped and uninucleate cells which are markedly different from those of the embryo proper (Fig. 7). Some of the cells become detached and ultimately come to lie free in the micropylar part of the embryo-sac.

The author takes this opportunity of expressing her thanks to Prof. J. Venkateswarlu, F.A.Sc., for his guidance and encouragement. She is also thankful to the Government of India for the award of a Research Training Scholarship during the tenure of which the work was carried out.

Dept. of Botany,  
Andhra Univ., Waltair,  
January 25, 1963.

P. CHANDRAVADANA.

1. Maheshwari, P., *An Introduction to the Embryology of Angiosperms*, New York, 1950.
2. Johansen, D. A., *Plant Embryology*, Waltham, Mass., 1950.

### EXTRACARPELLARY OVULES IN SOME RANALES

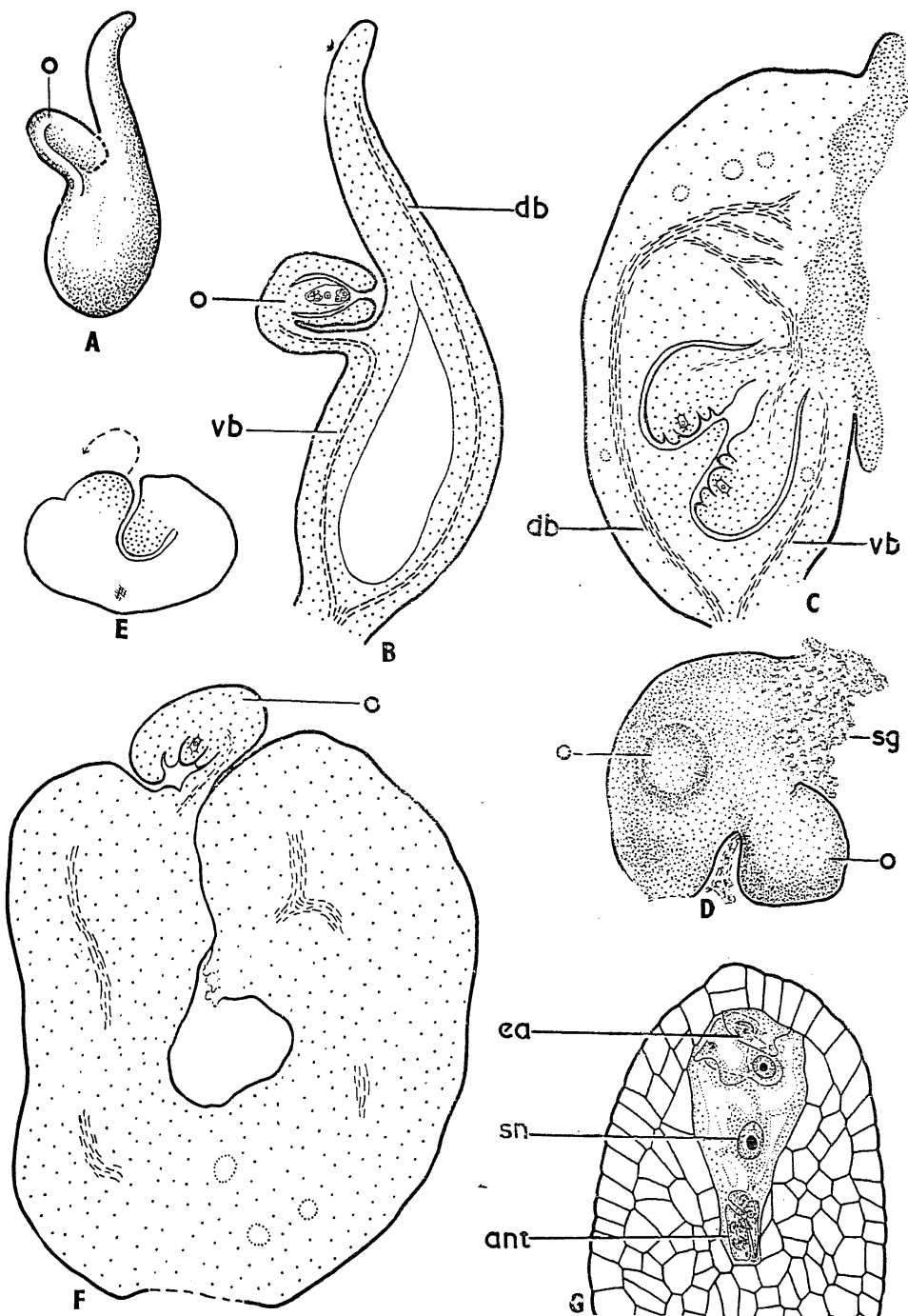
EXTRACARPELLARY OVULES have been observed in *Citrus*,<sup>1</sup> *Gossypium*,<sup>2</sup> *Holoptelea*,<sup>3</sup> *Peganum*<sup>4</sup> and *Vitis*.<sup>5</sup> However, so far as the authors are aware such ovules have not been reported in any member of the Ranales. During an embryological study of *Anemone rivularis* and *Schisandra grandiflora* we came across a number of carpels bearing ovules lying wholly outside the ovarian cavity. These are described here.

The flowers of *A. rivularis* and *S. grandiflora* were collected from Deoban and Mundali in the Western Himalayas. Formalin-acetic-alcohol was used for fixation and the imbedded material was sectioned at 10-15 microns. The preparations were stained with iron hæmatoxylin and fast green.

*Anemone rivularis*.—This species is characterized by a polycarpellary apocarpous gynoecium. Each carpel possesses a single pendulous, anatropous, crassinucellar and unitegminal ovule. There are only two vascular strands, the dorsal and the ventral. Of these the ventral bundle is unbranched and gives a supply to the ovule while the dorsal terminates into the style. In contrast to these normal carpels, a few bore ovules projecting along the ventral side (Figs. A, B). These are anatropous, crassinucellar and unitegminal and show a well-developed funicular vascular supply (Fig. B). Some of them contain mature embryosacs having a 3-celled egg apparatus, a secondary nucleus and three antipodal cells (Fig. G).

*Schisandra grandiflora*.—There are 20-30 carpels borne spirally on the elongated receptacle. Each carpel has a hunchback form and bears two anatropous, bitegminal and crassinucellar ovules lodged in the ovarian cavity (Fig. C). One dorsal and two ventral vascular strands traverse each carpel. The dorsal strand is curved and branched, and supplies the ovules while the ventral strands are short and unbranched (Fig. C). The two carpellary margins along the ventral side are closely approximated and form a papillose stigmatic crest (Figs. C, D).

In a few carpels one of the two ovules was seen outside the ovary along the ventral side (Fig. D). Out of 100 carpels examined by us as many as 5 showed this feature. Like the normal ovules the extracarpellary ovules are anatropous, bitegminal and crassinucellar, and have a short micropyle. However, they differ in the following respects: (a) the outer integument is more massive and shows 2 or 3 additional layers of cells in comparison to the normal ovules (Figs. C, F); (b) the placentation is marginal instead of laminar, and the ovules are directly attached to the ovary wall, there being no funiculus (Fig. F); and (c) the vascular supply is greatly reduced (Fig. F). In addition the cytoplasm and the nuclear contents of the megaspore mother cell are less prominent than in normal ovules indicating that they will not develop further (Fig. F).



FIGS. A-G. Fig. A. *Anemone rivularis*, carpel showing a 'naked' ovule (surface view),  $\times 35$ . Fig. B. Same in longitudinal section,  $\times 70$ . Figs. C-F. *Schisandra grandiflora*. Fig. C. L.s. carpel,  $\times 120$ . Fig. D. Abnormal carpel bearing a 'naked' ovule,  $\times 35$ . Fig. E. T.s. young carpel showing two ovular primordia; note that one of the primordia is growing away from the ovarian cavity as indicated by the arrow,  $\times 314$ . Fig. F. T.s. old carpel bearing a 'naked' ovule,  $\times 120$ . Fig. G. A. *rivularis*, l.s. nucellus of an extracarpellary ovule containing mature embryo sac,  $\times 430$ . (ant, antipodal cells; db, dorsal bundle; ea, egg apparatus; o, ovule; sg, stigmatic crest; sn, secondary nucleus; vb, ventral bundle.)

The development of the carpel in *Anemone* and *Schisandra* follows the peltate and conduplicate patterns respectively. A probable explanation for the origin of the extracarpellary ovules in these plants is that during the early stages of ontogeny, the unilateral growth of the ovular primordium becomes reversed so that it begins to develop in an opposite direction, i.e., away from the ovarian cavity rather than towards it. Figure E illustrates the ovular primordium in a very young pistil of *S. grandiflora*. This ovule would become extracarpellary if it continues to grow in the direction indicated by the arrow.

In *S. grandiflora* the vascular supply of the 'naked' ovules is much reduced, and the full development of the megaspore mother cell into the embryosac was never observed. On the other hand, *Anemone* has a well-developed funicular vascular strand and the development of the embryosac takes place normally.

We are grateful to Dr. R. N. Kapil and Professor P. Maheshwari for their interest and encouragement. Thanks are also due to Mr. M. R. Vijayaraghavan for useful discussions. Appreciation is expressed to the Council of Scientific and Industrial Research, and the Ministry of Scientific Research and Cultural Affairs, New Delhi, for the award of research fellowships to us.

Department of Botany, S. JALAN.  
University of Delhi, N. N. BHANDARI.  
Delhi-6, February 15, 1963.

1. Farooq, M., *Curr. Sci.*, 1952, **21**, 72.
2. Abraham, P., *J. Indian bot. Soc.*, 1935, **14**, 291.
3. Kapoor, S. P., *Beih. bot. Zbl.*, 1937, **57**, 233.
4. Shukla, R. D., *J. Indian bot. Soc.*, 1955, **34**, 282.
5. Baranov, P., *Ber. dtsch. bot. Ges.*, 1927, **45**, 97.

#### ON THE ANATOMICAL STRUCTURE OF THE PINNAE OF SOME SPECIES OF *CYCAS* L.

THE anatomical structure of the pinnæ has been investigated in thirteen species of *Cycas*, viz., *C. beddomei* Dyer, *C. cairnsiana* Muell., *C. celebica* Miq., *C. circinalis* Linn., *C. comorensis* Bruant, *C. media* R. Brown, *C. micholitzii* Dyer, *C. pectinata* Griff., *C. revoluta* Thunb., *C. rumphii* Miq., *C. seemannii* H. Brown, *C. siamensis* Miq., and *C. thouarsii* Engl. The margins of the pinnæ in *C. beddomei*, *C. cairnsiana* and *C. revoluta* are more or less revolute but those of the rest are flat. A surface view of epidermal cells of the pinnæ shows straight

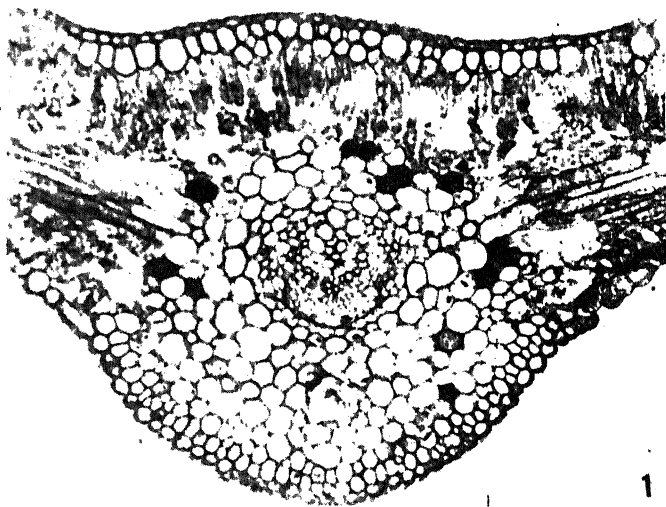
or arched anticlinal walls in all species except *C. micholitzii* where they are sinuous (see Fig. 2). Such cells are previously reported only in *Stangeria*. A characteristic feature of the genus is the presence of more or less prominent simple pits in the surface wall of epidermal cells.<sup>1</sup> The pinnæ of *C. comorensis* and *C. micholitzii* are unique in being regularly amphistomatic although the number of stomata on the upper side is usually small. All other species are typically hypostomatic. The stomata on the lower side of pinnæ are as a rule confined to the epidermis of the lamina but sometimes a few of them may be seen over the lower epidermis of the midrib as well, e.g., in *C. circinalis*, *C. comorensis*, *C. pectinata* and *C. rumphii*. The guard cells are sunken but their poles are relatively raised. The depth of the epistomatal chamber is variable: in *C. revoluta* and *C. cairnsiana* it is a two cell deep pit while in *C. beddomei*, *C. pectinata*, *C. siamensis* and *C. thouarsii* it may be one or two cells deep. The epistomatal chambers of the rest of the species are shallow and only one cell deep. Besides having the usual dorsal, ventral and polar lignin lamellæ the guard cells in the stomata of *C. revoluta* show conspicuous longitudinal and radiating striations (see Figs. 3, 4). Similar striations are earlier reported only in *Stangeria paradoxa* and *Bowenia spectabilis*. These striations superficially look like those of the Equisetales<sup>2</sup> but they may differ in details. The hypodermal cells in *C. micholitzii* show transversely thickened bands. An outstanding feature of the pinnæ of *C. beddomei* is the presence of a mucilage canal on the phloem side of the midrib bundle (see Fig. 1). No mucilage canals occur in the pinnæ of any other species of *Cycas*.

Schuster<sup>3</sup> regards *C. beddomei* as a variety of *C. circinalis* subspecies *vera* but our observations show that the pinnæ of *C. beddomei* are clearly distinct from those of *C. circinalis* in being narrower and in having strongly revolute margins (flat in *C. circinalis*). The guard cells of the stomata in *C. beddomei* are sunken in one or two cell deep pits (cf. the single cell deep pits in *C. circinalis*). A lower palisade-like tissue which is absent in *C. circinalis* is present in *C. beddomei*. In *C. beddomei* a hypodermis is seen all through the upper side of the leaflet and it continues up to the lower limits of the revolute margins but in *C. circinalis* it is restricted to the margins. The presence of a mucilage canal on the phloem side of the midrib bundle of the pinnæ of

*C. beddomei* distinguishes it from all other species.

Likewise Schuster regards *C. pectinata* as a variety of *C. circinalis* but again the pinnæ of *C. pectinata* are distinct from those of *C. circinalis* in having relatively smaller rounded or

layer (the lower palisade-like cells are absent in the pinnæ of *C. circinalis*). On the contrary our observations seemingly confirm the suggestion that *C. pectinata* is a form of *C. siamensis*<sup>1</sup> or that *C. siamensis* is a form of *C. pectinata*<sup>2</sup> as the pinnæ of the two species resemble each other



FIGS. 1-4. Fig. 1. *Cyas beddomei*. Part of a transverse section of a leaflet showing a mucilage canal on the phloem side,  $\times 316$ . Fig. 2. *Cyas nicholitsii*. Upper epidermis showing sinuous-walled cells and a stoma,  $\times 72$ . Figs. 3-4. *Cyas revoluta*. Fig. 3. A stoma showing longitudinal striations in the guard cells (as seen in a mount with the inner side upwards),  $\times 870$ . Fig. 4. Sagittal section of a leaflet showing radiating bands in the guard cells,  $\times 506$ .

oval pits in the surface wall of their epidermal cells. The guard cells of the stomata of *C. pectinata* are sunken below one or two cell deep pits (in *C. circinalis* the pits are only one cell deep). The pinnæ of *C. pectinata* show an upper palisade as well as a lower palisadelike

in their form and structure. Again Schuster regards *C. seemannii* as a subspecies of *C. circinalis*; *C. thouarsii* as a variety of *C. circinalis* or its subspecies *C. madagasca-riensis* Miq., and *C. celebica* as a synonym of *C. rumphii* but the pinnæ of all these various

species differ from those of the respective taxa under which they are classed in the form and size of pits on the outer periclinal walls of their epidermal cells, the depth of their stomatal pits, the extent of their hypodermis or in the presence or absence of a lower palisade-like layer. The present study of the pinnæ of *Cycas* thus suggests that their epidermal characters (hypostomatic and amphistomatic pinnæ, form and structure of epidermal cells, size form and structure of pits on the surface wall of epidermal cells, depth of the stomatal pit, size and structure of the guard cells, etc.) can be helpful in the determination of its species if these are judiciously used in conjunction with their external features but their ultimate taxonomic value will depend on similar studies being extended to other species of the genus.

Dept. of Botany, DIVYA DARSHAN PANT.  
Allahabad Univ., DEVENDRA DATT NAUTIYAL.  
Allahabad, (India), January 25, 1963.

1. Porsch, O., *Jena*, 1905, p. 1; Karzel, R., Wiesner, *Festschrift*, 1908, 510; Thomas, H. H. and Bancroft, Nellie, *Trans. Linn. Soc.*, London, 1913, 8B, 155; Pant, D. D., *Jour. Indian Bot. Soc.*, 1953, 32, 145.
2. Thomas, H. H., *Phil. Trans. Roy. Soc.*, London, 1911, 202, 51.
3. Schuster, J. *Das Pflanzenreich*, IV. I, Cycadaceæ, 1932, 1.
4. Burkill, I. H., *A Dictionary of Economic Products of the Malaya Peninsula*, 1933, 1.
5. Hooker, J. D., *Flora of British India*, 1890, 5.

### MEIOTIC STUDIES IN *BOERHAVIA REPANDA* WILLD.

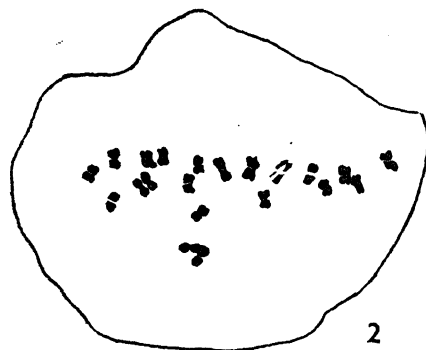
*Boerhavia* is an important genus of the family Nyctaginaceæ. Whereas some cytological observations have been reported on *Boerhavia repens* Linn.<sup>1</sup> (= *B. diffusa* Linn., *B. procumbens* Roxb.), no work along these lines has been done on some of the other species of the genus. The present note concerns the meiotic behaviour of chromosomes in *Boerhavia repanda* Willd.

The plants of *B. repanda* are straggling herbs with leaves in nearly equal pairs. The small pink flowers are present in slender long peduncled umbels. The species is commonly found in Delhi especially in the hedges of fruit orchards during rainy season.<sup>1</sup>

The flower buds were fixed in acetic-alcohol (1 : 3) for 24 hours. The anthers were

squashed in a drop of acetocarmine or propionocarmine for studying meiosis in the pollen mother cells. The chromosomes took a better stain with propionocarmine.

The pollen mother cells at diakinesis and metaphase I (Figs. 1 and 2) showed 21



FIGS. 1-2. Fig. 1. Shows 21 bivalents at metaphase I, ( $\times 1,718$ ). Fig. 2. Explanatory diagram of Fig. 1 ( $\times 1,900$ ).

bivalents. The distribution of chromosomes at anaphase I was regular, 21 chromosomes being present at each pole. The second divisional stages were also quite normal. Our studies have revealed 21 as the haploid chromosome number for *Boerhavia repanda*. Sharma and Bhattacharyya<sup>2</sup> reported  $n=47$  for *Boerhavia repens*. The plants of *Boerhavia repens* growing at Delhi also showed  $n=47$ . Most of the pollen mother cells at diakinesis had 46 bivalents and 2 univalents. The haploid chromosome number of 21 for *B. repanda* is much lower than that of *B. repens*. The two species, however, do not comprise a polyploid series.

The results reported in this note form part of a research scheme sanctioned by the Council of Scientific and Industrial Research, New



Delhi. We acknowledge gratitude to the Council for the financial support.

Department of Botany, S. L. TANDON.  
University of Delhi, G. R. RAO.  
Delhi-6, October 15, 1962.

1. Maheshwari, J. K., *Flora of Delhi State*, Thesis for Doctor of Philosophy, University of Delhi, 1957.
2. Sharma, A. K. and Bhattacharyya, U. C., *Indian Agriculturist*, 1961, 5, 9.

## CYTOLOGY OF JUJUBES

JUJUBE is one of the most common wild fruit trees in India in general, and Punjab in particular. Mostly the wild plants bear small and poor quality fruit. However, there are superior varieties which sell rather cheap, being within the reach of poor people. On account of this, it is aptly called as "the poor man's fruit". Jujube is so popular among this class of people that it is intimately connected with the folklore, particularly with the people of the Punjab. Besides yielding fruit, Jujube plant is put to a number of uses.

The present writers made a cytological survey of about 37 varieties of the species in Punjab. On the basis of this and other work on the genus,<sup>1-2</sup> there are reasons to believe that the genus is monobasic ( $x=12$ ), rather than tri-basic ( $x=10, 12, 13$ ). The numbers,  $x=10$  and 13, are in all probability unreliable. Furthermore, the number 12 is also found in other genera of the family. Judging the present results against this background, we have found 34 varieties to be tetraploid ( $2n=48, n=24$ ), one pentaploid ( $2n=60$ ), and two octoploid ( $2n=96, n=48$ ). Adding to these results the work of previous authors,<sup>3-5</sup> the Jujubes contain an array of forms, namely, diploid, tetra-, penta-, hexa- and octoploid.

Some important points arise out of the above findings which are here discussed in turn. The Jujubes are trees and the general impression is that in such genera polyploidy is rather low in incidence,<sup>7</sup> although there are quite a number of tree genera which are polyploid and others can be regarded as "cryptic polyploids". This aspect of Jujubes is particularly significant, because the genus *Ceanothus* is almost exclusively diploid ( $x=12$ ). Possibly apart from some intrinsic factors, three other factors may have aided the preservation of polyploidy in them, namely, the capacity to sprout repeatedly from the root-crown, weedy tendencies and man's interest since a long time. Regarding the last

point, it is pertinent to mention that Jujubes have been in cultivation since about 4,000 years in China,<sup>8</sup> and in India for about 3,000 years, as is clear from a mention of it in *Yajurveda Samhita*.<sup>9</sup> In contrast to Indian Jujubes, Chinese types have not been studied extensively cytologically, although there are about 400 varieties reported from that region. Two reports on the Chinese Jujubes<sup>3-4</sup> list them as diploids, while the present and Srinivasan's<sup>5</sup> work show that the Indian Jujubes are predominantly tetraploids, except for one solitary report of diploidy.<sup>3</sup> If these facts are substantiated by future work, more so on Chinese types, then they will have an important bearing on the discussion on the origin and differentiation of Jujubes in relation to the theories of the origin put forward by various workers.<sup>10-12</sup>

Regarding the nature of polyploidy, the present work has revealed amply that in the tetraploids the number of quadrivalents varies from 1 to 8 per cell. Coupled with this, there is secondary association (also recorded by Srinivasan<sup>5</sup>). Furthermore, their seedling progenies are not entirely uniform and the cultivators never prefer to raise seedling Jujubes. In short, tetraploids show two important properties, namely, quadrivalent formation and segregation. Both properties are the attributes of segmental allopolyploids. Associated with this there is also sterility (16-35%) found in the various tetraploid types. Obviously, this is the result of recombination between homologous chromosomes of the parents.

The higher polyploids also have multivalents and very likely are autopolyploids of the lower types accompanied by hybridization.

The origin of polyploidy in Jujubes can be inferred only on indirect grounds. A model could be suggested.

In woody species in general, barriers to hybrid inviability and sterility are more poorly developed than in herbs.<sup>6-13</sup> Although direct studies of this type have not been made on *Zizyphus*, yet from the indirect evidence (from meiosis of tetraploids) it appears to be quite true for this genus as well. Furthermore, in the allied genus *Ceanothus* ( $x=12$ ) it has been clearly shown that species differentiation is at ecospesific level.<sup>5-14</sup> Coupled with this, there is the entomophilous mode of pollination in Jujubes because of the nectariferous disk. This would result in rampant hybridization. The hybrids are likely to be reasonably fertile and once polyploids arise from such hybrids, these will be segmental allopolyploid in character. This model is fully borne out by the meiotic and

breeding studies. If the ensuing polyploids are of value, they are sure to be maintained in cultivation because of the propagation by grafts, which practice has been in operation from early times.

Post-Grad. Dept. of Botany. T. N. KHOSHOO.  
Jammu and Kashmir Univ., NARINDER SINGH.  
Naseem Bagh, Srinagar, India,  
February 27, 1963.

1. Darlington, C. D. and Wylie, A. P., *Chromosome Atlas of Flowering Plants*, 1955, London.
2. Cave, M. S., et al., *Index to Plant Chromosome Numbers*, 1955-60, North Carolina.
3. Morinaga, T., et al., *Bot. Mag. Tokyo*, 1929, **43**, 589.
4. Bowden, W. N., *Amer. Jour. Bot.*, 1945, **32**, 191.
5. Srinivasan, V. K., *Curr. Sci.*, 1952, **21**, 224.
6. Stebbins, G. L., *Variation and Evolution in Plants*, New York, 1950.
7. Darlington, C. D., *Chromosome Botany*, London, 1956.
8. Hayes, W. B., *Fruit Growing in India*, Allahabad 1945.
9. Macdonell, A. A. and Keith, A. B., *Vedic Index Part II*, Delhi, 1958.
10. DeCandolle, A. P., vide Watt, G., *A Dictionary of the Economic Products of India*, Calcutta, 1893, **6**(4).
11. Vavilov, N. I., *The Origin, Variation, Immunity and Breeding of Cultivated Plants*, Chronica Botanica, 1949-50.
12. Bailey, L. H., *The Standard Cyclopedia of Horticulture*, New York, 1947.
13. Stebbins, G. L., *Advances in Genetics*, 1958, **9**, 147.
14. Nobs, M. *Car. Inst. Wash. Year-Book*, 1951, **50**, 117.

### LOBELIA CHINENSIS FROM BOMBAY

*Lobelia chinensis* Lour., *Fl. Cochinch.*, 514, 1790; Wimmer in *Pfreich.*, 107(2): 609, 1953; Moeliono & Tuyn in *Fl. Males*, 6(1): 130-131, t. 14, 1960. *Lobelia radicans* Thunb. in *Trans. Linn. Soc.*, 2: 330, 1794; Roxb., *Fl. Ind.*, 1: 170, 1820; Clarke in *Fl. Brit. Ind.*, (3): 425, 1881; Nairne, *Fl. Pl. West. Ind.*, 167, 1894; Prin, *Beng. Pl.*, 634, 1903; Haines, *Bot. Bih. & Oris.*, 4: 501, 1921. *Pratia radicans* Don, *Gen. Syst.*, 3: 700, 1834; Graham, *Cat.*, 102, 1839; Dalzell & Gibson, *Bom. Fl. Suppl.*, 49, 1861.

This plant was first collected by Dr. D. K. Patel as a weed in a Bombay garden in October 1884 (Blatter Herbarium: Patel without number) and identified as *Lobelia radicans* Thunb. Mr. Bhagat, a field collector of this College, collected it again on 17-12-1956 from Victoria Gardens, Bombay. According to him, a small patch was seen in moist ground near the pond. The plant was identified by the

author and the sheets (Shah 8199-8202) are deposited in Blatter Herbarium, St. Xavier's College, Bombay. Since then, we have not been able to find it. At present it is rare.

Cooke does not mention this plant in *Fl. Pres. Bom.*, (1904), even though earlier workers (Graham, Dalzell & Gibson and Nairne) have listed it in their floras, dealing with plants from many parts of old Bombay Presidency. According to later authors, it is a common plant in gardens; in the vicinity of Bombay, so far, it has been found on but two occasions mentioned above.



FIG. 1. *Lobelia chinensis* Lour.

**Distribution.**—Native of China; in India found in Bengal, Bihar, Orissa and Bombay. Roxburgh (1820) seems to be the first to record it for India with a remark, "accidentally introduced from China into Botanic Garden at Calcutta where it blossoms freely".

**Critical notes.**—At first sight, the present plant may be mistaken for *Lobelia alsinoides* Lamk. which is common in Bombay; however, the two differ as follows:

Creeping herbs with terete stems;

Leaves 9-14 × 1-4 mm., ovate-elliptic or lanceolate. Flowers 15-17 mm. long, lilac. Two anterior anthers hairy at the tip, each with a hyaline seta . . . . . *L. chinensis*

Procumbent or suberect herbs, rooting only at the basal nodes, with more or less trigonous stems.

Leaves 7-22 × 6-20 mm., broadly ovate or triangular. Flowers 4-6 mm. long, blue or bluish-purple. All anthers penicillate . . . . . *L. alsinoides*

Thanks are due to Prof. P. V. Bole for his valuable suggestions.

Botany Department,  
St. Xavier's College,

G. L. SHAH.

Bombay-1, February 11, 1963.

## REVIEWS

**Polarised Light—Production and Use.** By William A. Shurcliff. (Harvard University Press), 1962. Pp. vi + 207. Price \$ 6.25.

'Many authors' says this book 'deal only with refraction, only with absorption or only with X-ray properties. The present book deals with all these properties....'. The reader who hopes to see the whole subject illumined by a distinctive unified treatment will be sadly disillusioned. It is not unfair to say that no perspective is given of the great scope of the topic of polarised light, of how it may be used in getting diverse information of fundamental physical interest, or even of the simple but colourful experimental phenomena in which this subject abounds and which have thrilled more ancient authors like Tutton. The uses of polarised light emphasized here relate to mundane problems such as control of headlight glare.

The book though written at an elementary level is not free from basic errors. For example, it is bad enough to state that any radius vector of the absorption ellipsoid is proportional to the absorption coefficient  $k$  for that vibration direction (instead of being proportional to  $1/\sqrt{k}$ ); but the author goes on to explain that a parallel plate of a dichroic crystal would exhibit two 'plano—absorbancy coefficients' (to use his terminology) given by the lengths of the semi-axes of the elliptic central section of the absorption ellipsoid. Optical crystallographers who have painfully attempted to determine the orientation of the absorption ellipsoid in crystals of low symmetry would indeed wish that matters had been so simple, and that they could so completely forget about the existence of an index-ellipsoid which fixes the fast and slow vibration-directions for the plate.

The diagrams are fairly accurately drawn except for a few notable exceptions. If it is true, as the author says, that 'the design of Nicol is difficult to describe and difficult to grasp', the figure illustrating the construction is not calculated to help matters; granted that the days are past when Iceland spar had to feature prominently in any introduction to polarised light it is yet not necessary to draw the calcite rhombohedron without a single obtuse corner.

In spite of its severe limitations the book would be a useful addition to a college library

for the sole reason that it gives the modern methods used for describing polarised light—in terms of the Poincare sphere, the Stokes parameters and the Jones vector. Readers who can stand a little more of mathematics would prefer a more comprehensive treatment such as that given in the article on 'Crystal-Optics' in the *Encyclopædia of Physics* (to which the author has briefly referred).

References to original publication—good, bad and indifferent—are liberally sprinkled throughout the book. The interested reader would however still have to wade through the original references, since no proper critical estimate is given of the worth or even of the scope of any publication.

S. PANCHARATNAM.

**The Physics of Rain Clouds.** By N. H. Fletcher. (Cambridge University Press, 200, Euston Road, London, N.W. 1), 1962. Pp. x + 386. Price 65 sh.

Since the Second World War cloud physics has become established as a distinct branch of atmospheric physics. It comprises the scientific study of the formation and constitution of clouds and the development inside them of snow, rain, hail and lightning. The techniques involved include the exploration of clouds with radar and aircraft and laboratory studies on the basic physics of the many processes involved.

Dr. Fletcher opens his account with a general description of clouds and cloud types (Chapter I on cloud dynamics is contributed by P. Squires). He goes on to consider condensation and condensation nuclei and the nature and characteristics of non-freezing clouds. The next few chapters are devoted to the nucleation and growth of ice crystals and the book concludes with several chapters on rainmaking and related topics.

The chapters on rainmaking contain abundant data particularly on the use of Silver Iodide as a nucleating agent. The ice nucleating properties of AgI were discovered by Vonnegut in 1947 and it is still the most important material used for this purpose. The author gives details of the production of AgI dispersions and the use of airborne and ground generators. One of the major problems in rainmaking at the moment is that of design of experiments. It is very difficult to establish controls and the variability

of the weather makes it difficult to analyse the results obtained from seeding experiments. Dr. Fletcher discusses the experimental results which are available. The Snowy Mountains experiment which is in progress in New South Wales has yielded some preliminary results which indicate a probable increase of 20% in precipitation due to cloud seeding.

The book is well produced with a complete bibliography and good subject index. It forms a very useful contribution to a very important subject.

I. J. SMALLEY.

**Fluid Mechanics (Vol. I).** By M. Manohar. (Asia Publishing House, Bombay-1), 1963. Pp. xii + 418. Price Rs. 22-00.

This book will be a popular addition to the existing available books on the subject of fluid mechanics. The subject of Hydraulics is no longer depending on the several empirical formulae developed from time to time, but is being developed on the modern classical theory of Hydrodynamics and fluid mechanics.

Beginning with properties of fluids and hydrostatics in Chapters I and II, the author deals with the relative motion of liquids, the laminar and turbulent flow, streamlines, flownet, etc., in Chapters III and IV. The total energy, internal energy, etc., are explained in detail along with the applications of Bernoulli's equation, cavitation, rotational and irrotational flow in Chapter V. Chapter VI deals with the characterisation of viscous flow, shear stress, flow between parallel boundaries, Stokes' law, etc. Various types of instruments for measuring viscosity have been described. Model analysis which is the most important in the study of models to predict the behaviour of the prototype is dealt with in Chapter VII. Buckingham's Pi theorem, Reynolds number, Euler number, Mach numbers, etc., are explained in the next chapter.

The characterisation of pipe flow and flow in open channels are dealt with in Chapters IX and X. One full chapter has been devoted to fluid measurements. Static pressure, velocity, discharge and other properties of fluid are explained. Flow in orifices, notches and measurement of discharge in rivers and channels are also dealt with in some detail.

The book contains a number of problems and questions. It can be recommended as a suitable text-book for Engineering students.

K. SEETHARAMIAH.

**Mineral Metabolism—An Advanced Treatise (Vol. 2, Part B)—The Elements.** Edited by C. L. Comar and F. Brenner. (Academic Press, New York), 1962. Pp. xvii + 623. Price \$ 20.00.

This comprehensive treatise on mineral metabolism in mammalian bodies has been produced according to the following plan: (1) physical and chemical principles; (2) physiological processes; (3) major tissues; and (4) the mineral elements. The first three subjects were dealt with in Vol. I which was issued in two parts A and B. Mineral elements form the subject-matter of Vol. II, which also consists of two separate parts. Part A of eight chapters, 17-24, contained besides the general article on the chemical composition of the body, detailed articles on the kinetics, function, physiological principles involved in the metabolism of phosphorus, calcium, magnesium, strontium and barium, and fluoride.

The book under review, which is Part B of Vol. II, contains the chapters 25-37, and deals with the remaining elements of importance, namely, sodium, potassium, chlorine, sulphur; iodine and bromine, iron, cobalt, copper, manganese, zinc, the rare earths, and selenium.

Contributors, who are experts in the field of study on which they have written, have approached and treated the subjects in their own way, but the information includes the latest developments. Exhaustive references to current literature are given at the end of each chapter.

There is no doubt that these volumes will remain an indispensable reference book for workers in the field of mineral metabolism, and also to physiologists and biochemists.

**Dover Mathematics Books for Engineers**

**Introduction to Nonlinear Differential and Integral Equations.** By H. T. Davis, Pp. xv + 566. Price \$ 2.00;

**Modern Operational Calculus.** By N. W. McLachlan, Pp. xiv + 218. Price \$ 1.75;

**Inductance Calculations, Working Formulas and Tables.** By F. C. Grover. (Dover Publications, 180 Varick Street, New York-14, N.Y.), Pp. xiv + 286. Price \$ 1.85.

*Introduction to Nonlinear Differential and Integral Equations*, presents a very clear and thorough introduction to an increasingly more useful area of mathematics. Taking the results of both the distinguished mathematical analysis of the past, and of modern machine computations into account the author undertakes an exposition of the field, indicating the advances

made up through 1960. Originally published by the United States Energy Commission, the work should prove valuable to mathematicians, physicists and engineers.

*Modern Operational Calculus* provides an exposition of the Laplace transform theory, and applies it to the solution of ordinary and partial differential equations. Containing many problems and illustrative material, the book is suitable as supplementary reading material for post-graduate engineers and technologists.

In the *Book Inductance Calculations, Working Formulas and Tables*, Professor Grover presents simple, single formulas to cover all of the most important cases of inductance. The use of this book will provide the student with accurate, easy and time-saving ways to calculate inductance. After an initial discussion of general principles and basic formulas, the book contains detailed treatment of all forms of coils, and a final section of convenient and accurate working formulas and tables. It will form a handy reference for all engineers, and all those concerned with computation of circuit inductance.

**Chemical Carcinogenesis.** By David B. Clayson. (J. and A. Churchill, Ltd., 104, Gloucester Place, London), 1962. Pp. 467. Price 72 sh.

*Chemical Carcinogenesis* by Dr. David B. Clayson is a very useful book. It has been written in a lucid style and can therefore be followed even by young scientists about to enter the field of cancer research. The author has taken particular care about the correctness of the details and has expressed his own opinions from time to time which would be found valuable by the reader.

As the author has stated in his preface, an emphasis is placed by him on fundamentals rather than on an excess of facts. The book has not therefore become a mere bibliography but one which contains the basic explanations and theories that form the basis of cancer research.

Literature on chemical carcinogenesis has grown tremendously in recent years and Dr. Clayson has meticulously classified each topic so that it could be referred to with ease. Although the specialist with experience behind him may find the book a simple treatise, it is just this type that is needed to guide the younger scientist. The biochemist, the biologist and the statistician will all find the book useful in many ways as all relevant points of view have been considered. V. R. KHANOLKAR.

## Books Received

From: (Academic Press, Inc., 111 Fifth Avenue, New York-3, N.Y.):

*Engineering Physics: An International Series of Monographs*—Vol. 1, *Real Gases*. Edited by A. B. Cambel, D. P. Duclos and T. P. Anderson, 1963. Pp. ix + 166. Price \$6.50.

*Radiation Effects on Organic Materials*. Edited by R. O. Bolt and J. G. Carroll, 1963. Pp. xv + 576. Price \$13.50.

*Advances in Genetics* (Vol. 11). Edited by E. W. Caspari and J. M. Thoday, 1963. Pp. ix + 394. Price \$13.00.

*Enzyme Histochemistry and Its Application in the Study of Neoplasms*. By M. S. Burstone, 1963. Pp. xii + 621. Price \$22.50.

*Nuclear Shell Theory*. By A. De Shalit and I. Talmi, 1963. Pp. x + 573. Price \$14.50.

*Synthesis of Feedback Systems*. By I. M. Horowitz, 1963. Pp. xiv + 726. Price \$16.50.

*Advances in Virus Research* (Vol. 9). By K. M. Smith and M. A. Lauffer, 1963. Pp. viii + 312. Price \$11.50.

*Advances in Food Research* (Vol. 11). By C. O. Chichester, E. M. Mlak and C. P. Stewart, 1963. Pp. ix + 454. Price \$14.50.

*Advances in Immunology* (Vol. 2). Edited by W. H. Taliaferro and J. H. Humphery, 1963. Pp. x + 390. Price \$12.00.

*Insect Pathology an Advanced Treatise* (Vol. I). Edited by E. A. Steinhaus, 1963. Pp. xvii + 661. Price \$19.00.

*Advances in Clinical Chemistry* (Vol. 5). Edited by H. Sobotka and C. P. Stewart, 1963. Pp. xiv + 329. Price \$12.00.

*Mathematics in Science and Engineering* (Vol. 6)—*Differential Difference Equations*. Edited by R. Bellman and K. L. Cooke, 1963. Pp. xvi + 462. Price \$13.75.

*Advances in Biological and Medical Physics* (Vol. 8). Edited by C. A. Tobias and J. H. Lawrence, 1963. Pp. ix + 457. Price \$15.00.

*International Review of Tropical Medicine*. Edited by D. R. Lincicome, 1963. Pp. xiv + 425. Price \$16.00.

*Solid State Physics—Advances in Research and Applications* (Vol. 14). Edited by F. Seitz, and D. Turn Bull, 1963. Pp. xv + 519. Price \$16.00.

*Methods in Carbohydrate Chemistry* (Vol. 2)—*Reactions of Carbohydrates*. Edited by R. L. Whistler and M. L. Wolfrom, 1963. Pp. xv + 572. Price \$19.50.

*Comprehensive Chemistry*. By J. Hicks. (Cleaver-Hume Press, Ltd., London W. 8), 1963. Pp. xvi + 805. Price 35 sh.

---

## SCIENCE NOTES AND NEWS

---

### Third International Congress on Catalysis

The Third International Congress on Catalysis will be held in Amsterdam, The Netherlands, from 20th to 25th July, 1964. The theme selected is The Mechanism of Heterogeneous Catalysis limiting the scope to the following two topics:

1. Molecular Description of the Catalytic Reaction and its Intermediate States.
2. Selectivity in Heterogeneous Catalysis.

All particulars about this Congress may be obtained from Dr. S. K. Bhattacharyya, Department of Applied Chemistry, Indian Institute of Technology, Kharagpur, West Bengal.

### Ionospheric Consequences of the Earth's Orbital Eccentricity

The earth's orbit round the sun being only nearly circular, but truly elliptical of eccentricity 0.0168, the earth-sun distance continuously changes during a year, attaining the maximum value in early July and the minimum in early January. The mean July value is about 3.4% greater than the mean January value. As a result of this orbital eccentricity the solar electromagnetic radiations, as received on the earth, are 6.5% weaker in July than in January. The effect of this annual variation of solar radiation intensity is, of course, small, and cannot be detected in measurements of, say, atmospheric temperatures because of the influence of large-scale air movements. However, a recent attempt to detect this annual effect on the ionosphere has proved successful.

Sir Edward Appleton, in a communication to *Nature* (1963 March 30), has presented the results of his analysis of ionospheric data to establish the annual variations observed in the E layer as a result of the earth's orbital eccentricity. The E layer has been chosen for this study because of the known regularity of its behaviour. It is an ionospheric layer in which the rates of electron production and electron loss are sensibly equal, so that the electron density is in a quasi stationary condition. As this is especially the case at noon, a proper approach to search for the required effect will be to analyze noon measurements of peak electron density suitably corrected for well-known disturbing factors.

The corpus of regular ionospheric measurements made over recent years by the world's ionospheric stations formed the basis of Appleton's investigation; more especially, the data on the hourly critical penetration frequency of the E layer as disclosed by the method of vertical sounding. From this it is possible to calculate the peak electron density,  $N_m E$ , of the E layer. The peak electron density, however, is dependent on the value of the sun's zenith distance  $\chi$ , and also on the sunspot activity. It is found that  $N_m E$  increases proportionately to  $R$ , the Zurich sunspot number. By using the averaged results for the period 1949-59 obtained from a large number of stations all over the world, the value of  $N_m E$  for each month of the year under both constant- $\chi$ , and constant- $R$  conditions can be calculated. In this way one might hope to detect an annual variation of  $N_m E$  resulting from the annual variation of the ionizing flux of radiation, now thought to be solar X-rays, which is responsible for the E layer formation.

Appleton's analysis of results shows a 7.5% decrease in the peak electron density value of the E layer for July compared to its value for January. Since the intensity of the solar ionizing rays must be 6.5% less during July than during January, the above result shows that besides the orbital eccentricity factor there may be other causes which contribute to the annual variation in the E layer.—(*Nature*, 1963, 197, 1239.)

### Raman-Type of Modified Scattering in X-Rays

When monochromatic X-rays are scattered by matter we have essentially two types of scattering: (a) the Rayleigh scattering, the elastic coherent type, associated with the process in which the electrons of the scattering atom remain in the same energy state before and after the scattering, and (b) the incoherent Compton scattering, associated with the transition of an electron of the scattering atom from an initial state  $i$ , to a final state  $f$ , in the continuum. The frequency of the scattered ray in the Compton process depends on the scattering angle and the frequency of the primary radiation, and is independent of the scattering element,

In the continuous transition from the coherent scattering of a bound electron to the Compton scattering of a free electron we should encounter the special case, "the characteristic modified scattering", in which the frequency of the scattered radiation is changed by an amount corresponding to transitions between two bound states of the scattering atom. This is the phenomenon of partial absorption of a photon, the scattering atom being left in a discrete quantum state, and was discovered by Raman in the visible and the ultraviolet region, involving mostly the vibrational and rotational states of the scattering molecules.

The existence of the Raman-type of scattering in X-rays was reported by Das Gupta some years ago, and he has presented further work on the subject using curved crystals for precision scattering data.

Experiments were done with lithium, lithium oxide, lithium fluoride, beryllium and boron as the scattering materials, and radiation from copper target was used as the primary X-radiation. Successful photographs have been obtained showing sharp characteristic modified lines at calculated energy gaps on the longer wavelength side of the primary beam. The K term values of Li, Be and B, and the  $L_1$  term values of F in LiF calculated from the observed modified lines are found to agree well with their known values. The difference between the incident ( $h\nu_0$ ) and the modified ( $h\nu_m$ ) energy gives the critical absorption discontinuity for the electron ( $q$ ), whose transition is involved in the scattering process. The process can be represented by the equation:  $(h\nu_0 - h\nu_m) = \Delta E = (E_i - E_f) = h\nu_q$ . —(*Phys. Rev.*, 1962, 128, 2181.)

#### Radio Measurements of a Man-Made Radiation Belt

The Jicamarca (Peru) Observatory of the National Bureau of Standards (NBS) has made a series of measurements of the synchrotron radiation emitted by the man-made belt of high-energy electrons formed by a high-altitude nuclear detonation. (The electromagnetic radiation emitted by energetic electrons moving in a magnetic field is called synchrotron radiation because it was first discovered in studies involving the particle accelerator called a synchrotron). These measurements, made at 30 and 50 Mc./s., determine the number, energy spectrum and decay rate of the electrons trapped by the earth's magnetic field, and lead to

an improved understanding of the physics of the upper atmosphere.

The test shot which produced the artificial radiation belt was fired at a height of 400 km. above Johnson Island on July 9, 1962. Measurements of this belt were made with ground-based equipment as well as with satellite instruments. The NBS ground antenna consisted of an array of crossed dipoles covering an area of  $288 \times 288$  m. (22 acres), and this was used to measure the total radio noise power at 50 mc./s. and the polarization of the synchrotron radiation.

Record of the radio noise power at the time of the detonation indicated a large peak some 6 minutes after the blast, corresponding to the first passage of the energetic electrons over the antenna, and a second less-well-defined peak 25 minutes after the first peak, indicating the second passage of the electrons. Polarization measurements showed that the radiation was almost linearly polarised.

Day-by-day measurements showed that about one half of the radiation had decayed in about two months. On this calculation about 15% of the original radiation may be present after one year. The energy spectrum showed the highest energy as 6 Mev. Rough calculations gave the number of electrons in the belt as  $10^{24}$  which agrees well with measurements with satellites.—(*J. Frank. Inst.*, 1963, 275, 142.)

#### Optical Transistor

Gallium arsenide, the crystal that has recently come into prominence for laser action, has now been used to make an optical analogue of the junction transistor, a device for amplifying or switching electric signals. In a conventional transistor the incoming signal stimulates an internal flow of electric charges, which may be carried either by electrons or "holes". In the new optical transistor some of the incoming electrical signal stimulates the emission of light in the first layer of a three-layer structure. The light carries the signal across a middle, or base, layer and is absorbed in the third layer releasing electrons that constitute the output current. The advantage of the optical transistor is that light can cross the base region much faster than electrons or holes can. To obtain high-speed (or high frequency) operation in a conventional transistor the base must be made extremely thin to minimise signal travel time, and thinness is difficult to achieve. In the optical transistor extreme thinness is unnecessary.—(*Scientific American*, April 1963.)

### Conservation of Vector Current in Weak Interactions

As long ago as 1958 Feynman and Gell-Mann enunciated a conservation law to account for a peculiarity observed in weak interactions. In the muon decay and the beta decay of the neutron it was found that there was close equality of the vector coupling constant, even though neutrons spend much of their lives surrounded by a "virtual" cloud of pions, and muons do not interact with pions at all. Feynman and Gell-Mann reasoning by analogy from the electromagnetic situation, where the charge on the nucleon is conserved through its conversion into meson clouds and back again to the "base" particle, said that, similarly, a vector current must be conserved in the case of the neutron-pion mixture in weak interactions. Vector current gives the vector coupling constant for any weak decay such as that of the muon, the nucleon or the pion itself. Out of the theory came a specific prediction about the form of the beta decay of Boron-12 and Nitrogen-12 to Carbon-12. Many experimenters had tried to check this prediction but their work was not sufficiently accurate to uncover the small effect being looked for.

Now C. S. Wu of Columbia University has succeeded in demonstrating the truth of this law of conservation of vector current in weak interactions. Her work was done with the radioactive isotopes Boron-12 and Nitrogen-12, both of which decay into Carbon-12 through the weak interaction of beta decay. She compared the energy spectrum of the electron given off by boron and the positron emitted in the decay of nitrogen and obtained a result closely equal to that predicted by Feynman and Gell-Mann.—(*Scientific American*, April 1963.)

### Inverse Thermo-Remanent Magnetization

It is conventionally understood that thermo-remanent magnetization is produced by cooling a ferromagnetic body from a certain high temperature in a magnetic field. Nagata *et al.*, of the Geophysical Institute, Tokyo, report an observation in which stable remanent magnetization has been shown by magnetite which has been heated from a lower temperature to room temperature in a moderate magnetic field of 10 oersted. This is quite striking, since a heating process is usually understood to loosen a magnetic domain configuration while magnetic domains are 'frozen in' in a cooling process. This new type of remanent magnetization has been called the inverse type of thermo-

remanent magnetization (ITRM), as the direction of the temperature change producing the effect is opposite to the case of ordinary TRM.

The experiments were carried out at low temperatures with synthesized stoichiometric magnetite ( $\text{Fe}_3\text{O}_4$ ) of which grain sizes ranged over several tenths of a millimetre. The magnetite grains were packed in a glass tube 2 cm.  $\times$  0.2 cm. and magnetic intensity measurements were made with a ballistic magnetometer. The temperature of study was from  $-150^\circ\text{C}$ . to room temperature. Results show that the maximum production of ITRM was in the range of heating from  $-150^\circ\text{C}$ . to  $-120^\circ\text{C}$ .

The mechanism of ITRM can be explained by the marked change in the crystal anisotropy constants of magnetite at low temperature. (The crystal anisotropy constants of magnetite vanish at  $-143^\circ\text{C}$ .) It is interesting to speculate that the ITRM might be responsible for the origin of the stable natural remanent magnetization observed in some stony meteorites, as their environmental temperature before their entry into the earth's atmosphere is suggested to be very low.—(*Nature*, 1963, 197, 444.)

### Genetic Transformations with DNA

DNA molecules are the heredity bearing determinants of the living cell. They can be artificially transferred from one bacterial cell to another a phenomenon called DNA mediated genetic transformation. Until now it has not been known whether the process is restricted only to bacteria or whether it operates also in higher organisms including man and other mammals.

Dr. E. Szybalski and Dr. W. Szybalski, of the Wisconsin Cancer Research Laboratory, have presented the first clear evidence for genetic transformations in the hereditary material from human cells brought about by treatment with DNA extracted from other human cells. They developed a strain of test-tube cultured human cells which because of a genetic mutation were unable to produce an enzyme inosinic acid pyrophosphorylase (IMPPase). These cells were treated with DNA extracted from donor cells capable of producing the enzyme. As a result of this treatment, a very low proportion of the recipient cells (one per ten thousand) acquired ability to produce IMPPase.

Since these transformed cells bred true, the change was of heritable nature.

The crux of the experimental technique lay in the development of a very efficient selective system for detecting rare transformant cells among the overwhelming majority of



recipients. This was accomplished by exposing the treated recipient cells to a special medium containing a growth inhibitor, aminopterin, together with its antidotes hypoxanthine and thymidine.

Under these conditions the unmodified recipient cells were completely inhibited, since the utilization of hypoxanthine is dependent on the missing enzyme IMPase, whereas the transformant cells, which had acquired the ability to produce the enzyme, were able to grow normally.—(*J. Frank. Inst.*, 1963, 275, 194.)

#### Brain Signals Transmitted via "Telstar"

The recent report of success in transmitting brain waves across the Atlantic by way of the Telstar communication satellite holds promise of establishing a solar radio system network for making immediate medical advice available anywhere in the world.

Signals transmitted over Telstar by Dr. W. Gray Walter, of the Burden Neurological Institute at Bristol (England), were received by Dr. Reginald Bickford, of the Mayo Clinic, Minnesota (U.S.A.). These were of a patient's brain reactions to clicks and flashes of light transformed into telephone signals. The signals were then transmitted via Telstar to the United States, where they were analysed in a few seconds and the results sent back to Bristol almost immediately for comparison.

If this type of link can be relied on it means that application of very sophisticated and often expensive techniques will be possible from research centres anywhere in the world.

#### Journal of Scientific and Industrial Research

The Journal of Scientific and Industrial Research (JSIR), the scientific publication organ of the Council of Scientific and Industrial Research (CSIR), New Delhi, is being issued as from January 1963 under the following five separate Titles, the first four of which will be monthlies and the last one will be a quarterly.

1. *Journal of Scientific and Industrial Research.*
2. *Indian Journal of Pure and Applied Physics.*
3. *Indian Journal of Chemistry.*
4. *Indian Journal of Technology.*
5. *Indian Journal of Experimental Biology.*

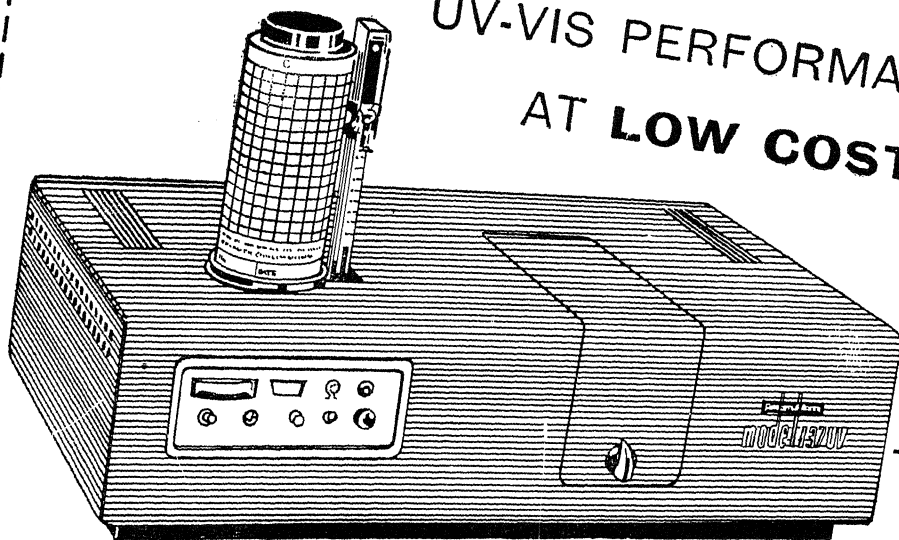
The annual subscription for each journal is Rs. 15.

The establishment of a large number of National Laboratories and Research Centres in the country under the aegis of the CSIR, has naturally increased the number of scientific communications that is being sent for publication and this expansion of the journal is to be welcomed.

#### New Technique for Preparing Lasers

Semiconductor lasers have been produced during the past few months by a number of research organizations, including Services Electronics Research Laboratories, Baldock, and Standard Telecommunication Laboratories, Ltd., Harlow, in the United Kingdom. The method used by Standard Telecommunication Laboratories, Ltd., Harlow, for making gallium arsenide lasers is based on a technique using cleavage, and leads to the manufacture of lasers with unusually good optical properties. A flat  $p-n$  junction is produced by diffusion in a carefully prepared slice of very homogeneous material, and this slice is broken into laser dice by applying mechanical pressure along accurately aligned axes with a hard stylus. If the original slice has been properly prepared, the gallium arsenide can be made to cleave along optically nearly perfect, parallel faces without difficulty. The laser is completed by adding suitable electrodes and mounting on a heat sink. The new process results in good and well-finished surfaces without the usual lapping and polishing operations, and the laser dice are extremely thin, and have, therefore, excellent thermal conduction properties. Lasers, with the high standard of perfection of their optical flats produced in this way, have been found to emit light having excellent spatial and polarization coherence.

# NEW SPECTROPHOTOMETER GIVES HIGHEST UV-VIS PERFORMANCE AT LOW COST



A new ultraviolet-visible spectrophotometer—the Perkin-Elmer Model 202—provides photometric and wavelength capabilities you expect from more expensive instruments. Its low price brings it within the range of any lab budget.

The Model 202 covers two regions: 190 to 390  $m\mu$  in the ultraviolet, and 350 to 850  $m\mu$  in the visible. Two scanning speeds—two and eight minutes per scan—are available for survey or precise work.

## FEATURES

**EASE OF OPERATION.** Minimum controls, plus Automatic Gain Control and auto programming, makes the Model 202 easy to run. Records linearly in absorbance units (0-1.5)

**GRAPHICAL NULL RECORDING:** For high accuracy in quantitative analysis, plus excellent reproducibility.

**AUTOMATIC GAIN CONTROL:** An exclusive feature, automatically increases sensitivity of the system in high absorption areas. Makes the most difficult differential measurements routine.

**Notebook-size Chart:** Spectra of each range recorded on standard 8½ x 11 chart, with large ordinate for accuracy. Linear wavelength presentation. Specifications are:

	ULTRAVIOLET	VISIBLE
Resolution	0.2 $m\mu$ at 250 $m\mu$	1.5 $m\mu$ at 600 $m\mu$
Photometric accuracy in absorbance units	±.01	±.01
Photometric reproducibility in absorbance units	.005	.005
Wavelength accuracy	±0.5 $m\mu$	±1.0 $m\mu$
Wavelength reproducibility	0.3 $m\mu$	0.5 $m\mu$

INSTRUMENT DIVISION  
**Perkin-Elmer Corporation**  
NORWALK, CONNECTICUT

Sold and serviced in India exclusively by

**BLUE STAR**

BLUE STAR ENGINEERING  
CO. (Bombay) Private LTD.  
SUKH SAGAR

SANDHURST BRIDGE, BOMBAY 7  
TELEPHONE : 41334

Also at CALCUTTA, DELHI,  
JAMNAPUR

# THE TRICHROMATIC HYPOTHESIS

SIR C. V. RAMAN

“MY Design in this Book is not to explain the Properties of Light by Hypotheses, but to propose and prove them by Reason and Experiments.” So reads the opening sentence of Newton’s classical work on Optics in the first book of which the foundations of the theory of colour were firmly laid and a bridge thus built between the physics and the physiology of vision. Precisely what Newton had in mind when he made the reference to hypotheses contained in this sentence may be inferred from the following passage which appears towards the end of his book. “As in Mathematicks so in Natural Philosophy, the Investigation of Difficult Things by the Method of Analysis ought ever to precede the Method of Composition. This Analysis consists in making Experiments and Observations, and in drawing general conclusions from them by Induction and admitting of no objection against the Conclusions but such as are taken from Experiments, or other certain Truths. For Hypotheses are not to be regarded in experimental Philosophy.” From these remarks it is clear that the hypotheses which Newton had in mind are assumptions of an arbitrary character not based on well-established facts of observation.

Newton’s aversion to hypotheses was not unjustified. For, there is a danger in adopting hypotheses when no real knowledge is available of the facts of the subject. A species of self-deception then becomes possible leading one to beliefs which are either wholly unjustified or else are only half-truths. Further, they are liable to make one blind

to facts which come to light later and which are themselves a patent contradiction of the hypothetical assumptions. These remarks are made here with special reference to the hypothesis originally put forward by Thomas Young and now known and referred to generally as the trichromatic theory of vision. That the theory is based on *ad hoc* assumptions and not on any well-established facts will be made clear later on. It will suffice here to mention that Young himself thought that the three primary sensations were those of red, yellow and blue, and later changed over to red, green and violet as a better choice. But before commenting any further on Young’s hypothesis and its subsequent history, it appears desirable in the first instance to state the actual facts of the subject.

We may usefully begin by quoting in Newton’s own words the conclusions which he arrived at as the result of his studies on colour. In characteristic fashion, he summed them up in two “definitions” which are reproduced below verbatim:

DEFINITION VII: *The Light whose Rays are all alike Refrangible, I call Simple, Homogeneous and Similar; and that whose Rays are some more Refrangible than others, I call Compound, Heterogeneous and Dissimilar. The former Light I call Homogeneous, not because I would affirm it so in all respects, but because the Rays which agree in Refrangibility, agree at least in all those their other Properties which I consider in the following Discourse.*

DEFINITION VIII: *The Colours of Homogeneous Lights, I call Primary, Homogeneous and Simple; and those of Heterogeneous Lights, Heterogeneous and Compound. For these are always compounded of the colours of Homogeneous Lights; as will appear in the following Discourse.*

Newton's ideas are very clearly expressed in the foregoing extracts. In the first place, he recognised that the physically simplest forms of light—which we would describe today as radiations manifesting themselves as single sharp lines in the spectrum—are also the exciters of the primary or simple physiological sensations which are the pure colours of the spectrum. Newton also recognised that the sensations excited by polychromatic light are compounded of these primary sensations and are, therefore, necessarily of a more complex character.

That the sensations excited by monochromatic light are the primary physiological sensations and that these are quite as numerous as the colours which can be perceived as distinct from each other in a pure spectrum is established by various facts of observation. On no other basis can a reasonable explanation be offered for the fact that our visual faculties enable us to distinguish between the colour of closely adjacent regions in the spectrum. Indeed, in some parts of the spectrum, a difference of as little as ten angstroms in the wavelength of the light suffices to produce an observable difference in colour. Then again, if monochromatic light be admixed with white light, we can still perceive and recognise the colour in such admixture and what is perhaps even more significant is that our ability to discriminate between the colours of closely adjacent regions of the spectrum is not altered appreciably even

when they are both admixed with substantial proportions of white light.

Light, according to Newton's ideas expounded in the third book of his treatise, is of a corpuscular nature. In other words, it consists of small bodies emitted by the source of light, their sizes being different for the differently coloured rays of the spectrum and altering continuously as we pass from one end of the visible spectrum to the other. On this basis, the existence of a definite relationship between the refrangibility of light and its observed colour is only to be expected. To quote Newton's own words, "nothing more is requisite for producing all the variety of colours, and degrees of refrangibility, than that the Rays of Light be Bodies of different Sizes". It was inevitable, therefore, that Newton should recognize the colours of the spectrum as the primary, homogeneous, and simple colours and the colours of lights of different sorts mixed with each other as heterogeneous and compound.

The corpuscular view of the nature of light favoured by Newton fell into disrepute during the nineteenth century. It was no accident that the physicists who were associated with the development of the wave-theory of light thought fit to reject Newton's conclusions regarding colour and its perception and attempted to replace them by other assumptions of a hypothetical nature. They could not have foreseen that all such attempts were foredoomed to failure and that the corpuscular concept of light would emerge once again, triumphantly vindicated. The different sizes of the particles of light contemplated by Newton are replaced by the different magnitudes of the energy-quanta which they represent.

It is a fact of observation that the eye can discern some 150 or more different

hues in the spectrum. Rejecting this as an inexplicable achievement of our faculty of vision, Young postulated that there are only three different "principal" colours and that the rest are only derivatives. The question then arose, which three colours should be chosen as the "principals". Young's first choice was that of the colours red, yellow and blue. Later, he discarded these and adopted red, green and violet as his favourites. He then drew an equilateral triangle having these three colours at the vertices, white at the centre and the other spectral colours as points lying on its two sides.

Young's triangle of colours was just pure phantasy. For, later studies have shown in the most conclusive manner that the pure colours of the spectrum stand in a category by themselves and that they cannot be equated to the result of any superposition of other colours. This fact alone is sufficient to prove the correctness of Newton's analysis of the subject of colour and is a shattering blow to the ideas underlying the trichromatic hypothesis. But, as has been remarked earlier, believers in *ad hoc* hypotheses do not readily admit defeat when confronted by the discovery of new facts. They assiduously seek to find ways of escape from the consequences of such discoveries.

One of the several ways in which it has been sought to bolster up a belief in the validity of the trichromatic theory, instead of allowing it to join the limbo of discarded hypotheses, has been to suggest that all observable colours could be represented as equivalent to the result of superposing three suitably chosen colours in suitably chosen proportions. The equivalence is represented in the form of an algebraic

equation, quantities being introduced therein known respectively as trichromatic coefficients and tristimulus values, suggestive of a mysterious power and significance for the number three in colour theory. Geometric representations have also been devised in which colours were represented as points in a system of trilinear co-ordinates. A critical examination of these representations of colour shows, however, that they are devoid of any real physical significance. This becomes evident when it is remarked that in the XYZ system which is generally adopted for the geometric representation of colour, the vertices X, Y, Z of the triangle do not represent any real physical colours, the entire triangle lying outside the area in which the points representing actual colours lie. Indeed, these representations mean little more than that any actually observed colour resembles the result of superposing an achromatic sensation upon a recognisable colour with a saturated hue, a fact which was known to and stated quite clearly by Newton in his treatise.

The subject of the sensations excited on our visual organs by polychromatic radiations is one of considerable interest and importance. One has only to recall the vast number of possibilities included in the words "polychromatic radiation" to appreciate that only observational data obtained on the widest possible basis and by methods not influenced by bias of any sort could be expected to reveal the real facts of the subject. So far from the trichromatic theory of vision having been of any real assistance towards the understanding of this difficult and complex field, it has only served to introduce error and confusion and stood in the way of any real advances in knowledge.

# THE CRYSTAL STRUCTURE OF $\text{Ba}(\text{OH})_2 \cdot 8\text{H}_2\text{O}$ AND THE CRYSTAL CO-ORDINATION OF THE BARIUM ION

H. MANOHAR AND S. RAMASESHAN\*

Department of Physics, Indian Institute of Science, Bangalore-12 (India)

THE investigation of the crystal structure of barium hydroxide octahydrate  $\text{Ba}(\text{OH})_2 \cdot 8\text{H}_2\text{O}$  was taken up as part of the programme of the department to study the crystal co-ordination of the  $\text{Ba}^{++}$  ion in various complexes. Additional interest stemmed from the fact that very few structural studies have been conducted on highly hydrated salts in general and hydroxides in particular.

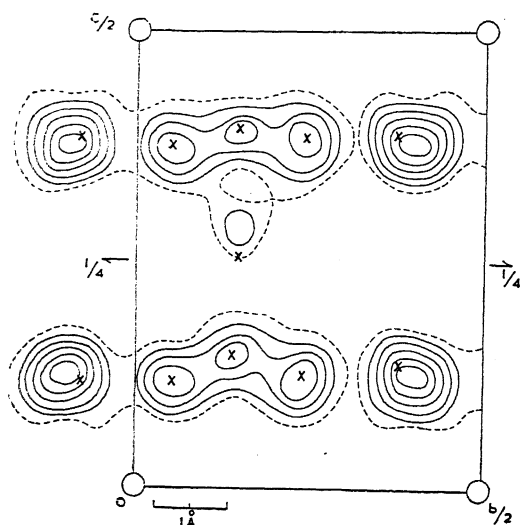


FIG. 1 *a*.  $\text{Ba}(\text{OH})_2 \cdot 8\text{H}_2\text{O}$ . [100] barium-removed Fourier projection. Contours are drawn at arbitrary intervals.

The substance was crystallised by evaporating a saturated solution of  $\text{Ba}(\text{OH})_2$  at room temperature. Rotation and Weissenberg photographs revealed that the crystal belongs to the monoclinic space group  $C_{2h}^2 - P2_1/n$  with four formula weights in the unit cell of dimensions  $a = 9.35 \text{ \AA}$ , unique axis  $b = 9.28 \text{ \AA}$ ,  $c = 11.87 \text{ \AA}$  and  $\beta = 99^\circ$ . Three-dimensional data were collected about the [100] and [110] axes on multiple films employing the Weissenberg technique. The intensities of the spots were estimated visually by comparison with calibrated intensity strips. The co-ordinates of barium were obtained by computing Patterson syntheses in the two projections and the signs of most of

the reflections could be fixed by the 'heavy atom' method. The structure was solved from two-dimensional data by the iterative process of Fourier and difference syntheses. The [100] barium-removed Fourier projection is shown in Fig. 1 (*a*). The final reliability factors for the [100] and [110] data are 0.11 and 0.12 respectively, the overall R-factor for 1020 visually observed reflections within the  $\text{CuK}\alpha$  sphere of reflection in eight zones being 0.124.

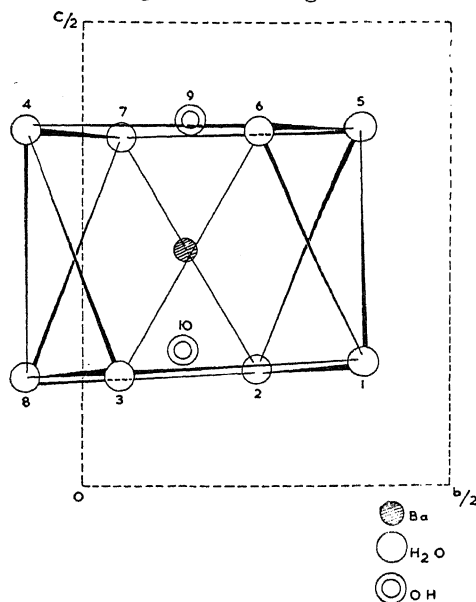


FIG. 1 *b*. Identification of atoms in the [100] projection. The antiprism co-ordination of the barium ion is shown, the axis of the antiprism being parallel to the  $c$ -axis.

In this structure, the barium ion is co-ordinated by eight water molecules which form a slightly distorted Archimedean antiprism,<sup>1</sup> the Ba-O distances varying between 2.69  $\text{\AA}$  and 2.77  $\text{\AA}$ . This is perhaps the first instance where this co-ordination polyhedron has been explicitly reported for the  $\text{Ba}^{++}$  ion. The antiprisms do not share atoms with one another. Each hydroxyl oxygen has close contacts with five waters and one hydroxyl group which form a distorted octahedron. The water molecules have an approximately tetrahedral environment, six out of the eight non-equivalent waters in the unit cell having one barium, one hydroxyl oxygen and

\* Present address: Department of Physics, Indian Institute of Technology, Madras 36 (India).

two water oxygens and the rest, one barium, two hydroxyl oxygens and one water oxygen as nearest neighbours. The structure is thus a slightly distorted version of tetragonal  $\text{Sr}(\text{OH})_2 \cdot 8\text{H}_2\text{O}$ .<sup>2</sup> Based on the short interatomic distances in the structure, a network of hydrogen bonds is proposed which links the antiprisms and hydroxyl groups with one another utilising all the hydrogen atoms in the unit cell.

Since the ratio of the univalent radii of  $\text{Ba}^{++}$  to  $\text{O}^{--}$  is 0.87, the barium ion should normally exhibit a co-ordination number of nine. In  $\text{Ba}(\text{ClO}_4)_2 \cdot 3\text{H}_2\text{O}$ , however, the number of oxygens surrounding barium has been found to be twelve and the co-ordination polyhedron is the icosahedron, while in  $\text{Ba}(\text{OH})_2 \cdot 8\text{H}_2\text{O}$  the co-ordination number is eight. A systematic survey was therefore made in the literature, of barium compounds whose structures had been solved to find out whether barium shows any other crystal co-ordination number. It was noticed that for the purpose of determining the crystal co-ordination in ionic crystals, the nearest neighbours alone at approximately the same distance from the cation were usually considered, atoms which were only slightly farther away being ignored. Further the shapes of the co-ordination polyhedra were identified only when they were of the standard symmetrical type such as octahedron, cube, etc., which are enumerated in

text-books. In cases where the co-ordination numbers were unusual, like seven, ten or eleven, beyond giving the number and distances of the nearest atoms, no attempt was generally made to investigate the nature and geometry of the polyhedra. In all these cases, the interatomic distances were calculated and the positions of atoms co-ordinating the barium ion were plotted in the most suitable projection, the heights being represented by metal rods cut to appropriate lengths. A study of the models led to the identification of some new geometrical figures for the co-ordination polyhedra. The present investigations reveal that the barium ion displays a range of co-ordination numbers from six right up to twelve.

Details of these investigations are being reported elsewhere. The writers wish to acknowledge the help given by Dr. G. Aravamudan of the Chemistry Department, Indian Institute of Technology, Madras, in growing the crystals of  $\text{Ba}(\text{OH})_2 \cdot 8\text{H}_2\text{O}$ . Thanks are due to Professor R. S. Krishnan for his keen interest in the problem.

1. Pauling, L., *The Nature of the Chemical Bond*, Cornell University Press, Ithaca, 1969, p. 544.
2. Smith, H. G., *Acta Crystallogr.*, 1953, **6**, 604.
3. Mani, N. V. and Ramaseshan, S., *Z. Kristallogr.*, 1960, **114**, 200.

## REVIEW OF RECENT RESULTS ON INTERNAL CONVERSION \*

M. K. RAMASWAMY

Department of Physics, Karnatak University, Dharwar-3

UNTIL a few years ago it was believed that all was well with the theory of internal conversion as originally developed by Rose<sup>1</sup> and his collaborators. This theory was based on the rather simplifying assumption that the nucleus can be treated as point charge. There was so much faith in this theory that experimentalists interpreted all their data on this and assigned multipolarities for gamma transitions. Experiments on some M1 transitions soon revealed discrepancies between theory and experiment in spite of the rather moderate precision with which the  $\alpha_k$ 's were determined. Sliv<sup>2</sup> recalculated the  $\alpha_k$  on a more realistic model, namely, the one in which the charge on the nucleus is distributed uniformly on a sphere of radius R. The inclusion of this

effect (static approximation) removed the anomalies observed in the case of M1 transitions. In general, the new calculations differed from Rose's especially for heavy nuclei, and predicted values which were a good deal larger than the point nucleus values. It must be pointed out that the  $\alpha(E2)$  was unaffected by these calculations.

Church and Weneser<sup>3</sup> made an important contribution to the theory of internal conversion when they pointed out the importance of the so-called penetration effect or dynamic effect. This effect which arises from the penetration of the atomic electron into the nuclear volume introduces new matrix elements into the conversion electron ejection different from that due to gamma-ray emission. This had the interesting consequence that when the gamma-ray matrix element was vanishingly small due to some selection rule, the new matrix element would in-

\* Presented as an invited paper at the Nuclear Physics Symposium, Bombay, Feb. 27 to March 2, 1963.

produce anomalous conversion coefficients, as for example, in the case of the  $l$ -forbidden M1 transitions which should have a vanishing gamma-matrix element. The effect on M1 transitions was defined in terms of an equation

$$\beta(\lambda) = \beta(\lambda=1) [1 - (\lambda-1) C(Z, k)]^2$$

in the usual notation where  $\lambda=1$  corresponds to Sliv's values.

$\lambda = m_e/m_\gamma$  is the ratio of the matrix element due to penetration and gamma-ray emission.

The factor  $C(Z, k)$  characterizes a quantity which is a function of the atomic number and transition energy.

Depending on the phase of the two matrix elements  $\lambda$  can be positive or negative which can thus make the observed  $\alpha_k$  values larger or smaller than Sliv's values, determined entirely by the structure of the nucleus. For instance, Church and Weneser calculated  $\lambda$  for  $\Delta l = 2$  M1 transitions, using single particle wave function to calculate  $m_e$  and empirical gamma-matrix element to determine  $m_\gamma$ . They found values of  $\lambda$  falling in the range 5-10 corresponding to a change of  $\beta(\lambda)$  up to 20% for a typical nucleus ( $Z=55$ ). It must be emphasized that very accurate experimental data are required to discern these small effects. As illustrations of the dynamic effect (Church and Weneser) one may cite the example of the 80 kev.  $l$ -forbidden M1 transition in  $\text{Cs}^{133}$  which was initially discussed by the author<sup>4</sup> and more recently by Subba Rao,<sup>5</sup> and in  $\text{Hg}^{200}$  discussed by Deutsch and Goldberg.<sup>6</sup>

Side by side with refinements in theory, within the past few years significant improvements in techniques for measuring the internal conversion coefficient have been made. In particular, the internal-external method developed by Hultberg and Stockenda<sup>7</sup> has been effectively and extensively used for an accurate determination of ICC. In brief, this method consists in measuring the ratio of internal and external conversion electrons, the latter being produced in a thin radiator in a magnetic spectrometer. The conversion coefficient is obtained by the use of the following equation

$$\alpha_i = (A_{i\text{int}}/A_{i\text{ext}}) f/\tau k d b c.$$

Here  $\alpha$  = internal conversion coefficient of the  $i$ -th shell;  $A_{i\text{int}}$  = intensity of the internal conversion electrons;  $A_{i\text{ext}}$  = intensity of the external photoelectrons;  $f$  = correction factor which accounts for the anisotropical distribution of photoelectrons;  $\tau$  = photoelectric cross-section;  $k$  = ratio of external and internal electron source strengths;  $d$  = thickness of the converter in

mg./cm.<sup>2</sup>;  $b$  = a dimensional factor; and  $c$  = a correction factor to account for differences in transmission of the magnetic spectrometer for the external and internal sources.

If the same source is used  $k=1$ .  $\tau$  and  $f$  are calculated theoretically and found to be quite accurate. Using this technique it has been possible to measure ICC to an accuracy of 3% or better. The internal-external method has the merit that ICC can be determined even in a complicated decay scheme which feature is absent in the peak to beta-spectrum (PBS) method which has the additional complication introduced by the uncertainty in the spectral shape.

As already indicated the inclusion of finite size effects (static and dynamic) remove the large discrepancies observed for M1 transitions. However, E2 conversion coefficients changed little in the new calculations. Sliv remarked that dynamic effects may affect the so-called retarded E2 transitions.

Stelson and McGowan<sup>8</sup> measured the  $\alpha_k$  of some fast E2 transitions and found the experimental values to be about 20% higher than theory. Other discrepancies of 10 to 20% have been reported in the  $\alpha_k$  values for some unhindered transitions. Subba Rao<sup>9</sup> collected all the available data on  $\alpha_k$  for E2 transitions of the type  $(2^+ \rightarrow 0^+)$  and comparing with theory concluded that measured  $\alpha_k$  tended to be systematically higher than theory. He also suggested that a correlation might exist between nuclear deformation and deviations in  $\alpha_k$  values. A similar analysis on  $\alpha_k$  of  $6^+ \rightarrow 2^+$  E2 transitions carried out by the author<sup>10</sup> seemed to confirm Subba Rao's findings.

Other classes of E2 transitions can be found in transitions of the type  $(6^+ \rightarrow 4^+)$ ,  $(4^+ \rightarrow 2^+)$ , etc. In these cases it is necessary to prove that the M3 admixture is either small or calculable. This can be done by means of angular correlation experiments. Recently data on E2 conversion coefficients of several transitions including the type  $(4^+ \rightarrow 2^+)$  have come in. These indicate overall agreement with theory. Where deviations occur they are found to lie within experimental uncertainty. Only in the case of the 412 kev.  $(2^+ \rightarrow 0^+)$  E2 transition in  $\text{Hg}^{198}$  the experimental value was found to be 6% lower than theory. More recent reinvestigations by Hamilton,<sup>11</sup> and Wapstra<sup>12</sup> on rare-earth transitions have confirmed previously-found deviations. An interesting and intriguing case has been reported by Edwards and Boehm.<sup>13</sup> They measured  $\alpha_k$  for  $8^+ \rightarrow 6^+$ ,  $6^+ \rightarrow 4^+$ ,  $4^+ \rightarrow 2^+$  and  $2^+ \rightarrow 0^+$  E2



transitions in  $\text{Hf}^{180}$ ; for the first three transitions they found experimental values to be  $(10 \pm 8)\%$  lower than theory and for the last transition  $(6 \pm 8)\%$  higher than theory. This situation, if confirmed, clearly calls for an explanation.

Summarising, it may be said that there is general agreement between theory and experiment when finite size effects are taken into account. The observed deviations from theory in the case of unhindered E2 transitions<sup>5</sup> are interesting in that they are, in the first place, unexpected and secondly, pose a challenge to theoreticians. More precise data in the rare-earth region may be expected in the near future which should help to clear up the question of whether or not there is any correlation between nuclear deformation and deviations in  $a_K$  from theory. Finally it would be highly welcome if independent checks on the results from

the IEC method can be made. However, at the present time such a prospect does not appear bright.

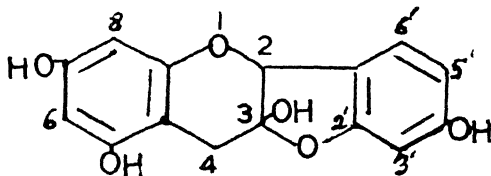
1. Rose, M. F., In *Beta and Gamma Ray Spectroscopy*, North-Holland Publishing Co., 1955.
2. Sliv, L. A., *Zhur. Theoret. Fiz.*, 1951, **21**, 770.
3. Church, E. L. and Weneser, J., *Phys. Rev.*, 1956, **104**, 1382.
4. Ramaswamy, M. K., *Ibid.*, 1960, **119**, 2021.
5. Subba Rao, B. N. (Personal Communication).
6. Dutch, B. I. and Goldberg, N. R., *Phys. Rev.*, 1960, **117**, 818.
7. Hultberg S. and Stockendal, R., *Arkiv. Physik.*, 1959, **14**, 565.
8. Stelson, P. H. and McGowan, F. K., *Phys. Rev.*, 1957, **107**, 1674.
9. Subba Rao, B. N., *Nuovo Cim*, 1960, **17**, 189.
10. Ramaswamy, M. K., *Ibid.*, 1960, **18**, 1287.
11. Hamilton, J. H., et al., *Nucl. Phys.*, 1962, **36**, 567.
12. Wapstra, et al., *Ibid.*, 1962, **38**.
13. Edwards, W. and Boehm, F., *Phys. Rev.*, 1961, **121**, 1499.

## STRUCTURE OF CYANOMACLURIN

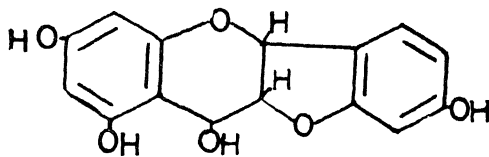
GEETA CHAKRAVARTY AND T. R. SESHADRI

Chemistry Department, University of Delhi, Delhi

IN an earlier publication<sup>1</sup> chemical and spectral data were provided in order to show that cyanomaclurin is a derivative of a flavan-3,4-diol. Close comparison with the catechins definitely established the absence of a  $>\text{CH}_2$  group in the 4-position as embodied in the original structure of Appel and Robinson<sup>2</sup> (I).

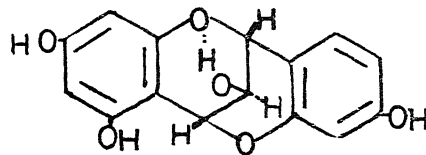


I



II

There was no definite way of fixing up the oxygen involved in the formation of the fourth ring. Established analogies would support dihydrofuran ring formation (II) using the adjacent 3-position; homopterocarpin and rotenone may be cited as well-known examples. There are certain reactions which could be expected from a benzyl alcoholic compound of structure (II) such as oxidation with manganese dioxide or catalytic reduction; but they could not be effected successfully. This was considered to be due to simultaneous substitution in both 5 and 3-positions. Similar lack of oxidation with manganese dioxide is found in compounds like leucocyanidin methyl ether.



III

More recently a modified structure (III) has been proposed by Nair and Venkataraman.<sup>3</sup> This contains a dihydropyran ring involving the benzylic hydroxyl in the 4-position. The chief

arguments given by the above workers are the following: (1) failure of cyanomaclurin trimethyl ether to be oxidised with manganese dioxide and chromium trioxide; (2) lack of reduction even by drastic treatment with Raney nickel; (3) in cyanomaclurin methyl ether the benzylic protons in 2 and 4-positions have more or less the same  $\tau$  values (4.61 and 4.88) and that in the 3-position have a markedly different value 5.67. The acetate of this ether gives for the 3-proton a lower value which is nearly the same as for the other protons in the 2 and 4-positions which are unaffected. This effect could be explained only by placing the free hydroxyl in position 3. It was also brought out by them that there was no coupling between the protons in the 3 and 4 positions as is found in the case of flavan 3 : 4-diols (axial-equatorial)<sup>4</sup> and the absence of such coupling indicates that the H in the 3 position is *trans* to the protons in the 2 and 4 positions.

Cyanomaclurin	Homopterocarpin	Rotenone	Dihydrorotenone	Dehydrorotenone
1081 (s)	1075 (m)	1090 (s)	1050 (m) cm. <sup>-1</sup>	..
1070	1266 (s)	1280 (m)	1270 (m)	1279 (m) cm. <sup>-1</sup>
..				

The above structure (III) seems to be reasonable and we have examined its validity further in the following manner.

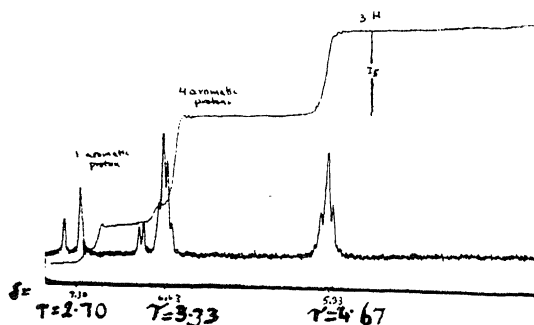
(a) We have constructed molecular models in accordance with both the alternative structures II and III; the former seems to involve some strain, the latter is free from strain and is easily constructed using Catalin models. This is brought out in the photographs. The side phenyl has to be axial in this structure and so also the oxygen link in the 4-position. As mentioned in the next para the hydroxyl in the 3-position is also axial facilitating hydrogen bonding with the oxygen in position 1. Consequently the three protons in the 1, 2 and 3 positions are equatorial, protons in the 1, 2 positions *trans* and those in the 2, 3 positions *trans*.

(b) In the case of catechins it was earlier established that the hydroxyl in the 3-position is involved in intramolecular hydrogen bond formation. This is shown by the I.R. absorptions of the hydroxyl groups of (+) catechin and (-) epicatechin tetramethyl ethers in CCl<sub>4</sub>, which occur at 3594 and 3587 cm.<sup>-1</sup> respectively.<sup>5</sup> These low hydroxyl stretching frequencies and the absence of a free OH band near 3630 cm.<sup>-1</sup> indicate intramolecular hydrogen bonding of axial hydroxyl groups as originally postulated by Roberts.<sup>6</sup> In the I.R. spectrum of cyanomaclurin trimethyl ether in CHCl<sub>3</sub> solution, the hydroxyl group absorbs at 3450 cm.<sup>-1</sup> (doublet)

indicating the existence of a 3-OH grouping which is hydrogen bonded more markedly than in the case of the catechins.

(c) A study has now been made of the I.R. spectra of a number of compounds having both 5- and 6-atom oxide rings in their structures just as in cyanomaclurin. Homopterocarpin, rotenone, dihydrorotenone and dehydrorotenone show the presence of a fairly strong band around 1280 cm.<sup>-1</sup> and this band may be attributed to the presence of a dihydrofuran ring in the molecule. Cyanomaclurin does not show any prominent band around this region. On the other hand the characteristic peak for a pyran ring comes as a strong band around 1075 cm.<sup>-1</sup> in these compounds; cyanomaclurin has a strong doublet in this region and dehydrorotenone in which this 6-atom ring has undergone change has not got the absorption. The peaks around these two regions are tabulated below for all the above-mentioned compounds.

(d) The NMR spectra of cyanomaclurin and its derivatives along with those of catechins have now been reconsidered. In cyanomaclurin and its trimethyl ether the protons in the 2 and 4 positions are indistinguishable and have  $\tau$  values between 4.61 and 4.92. On the other hand the proton in position 3 has almost the same value in both compounds,  $\tau = 5.73$  and 5.67 respectively. Acetylation of either cyanomaclurin or its methyl ether does not affect the values for proton in 2 and 4 positions whereas  $\tau$  value for the hydrogen in the 3 position is lowered by nearly a unit. Nair and Venkataraman<sup>3</sup> have recorded the lowering for the methyl ether acetate. In our record for cyanomaclurin acetate (see chart) the  $\tau$  values for the protons



NMR spectra of cyanomaclurin tetraacetate.

in 2, 3 and 4 positions are quite close being round about 4.7. Another point may also be mentioned and it relates to a comparison with the NMR spectrum of catechin tetramethyl ether. The proton in the 3 position has the  $\tau$  value 5.71 which is almost the same as the value of the corresponding proton in cyanomaclurin.

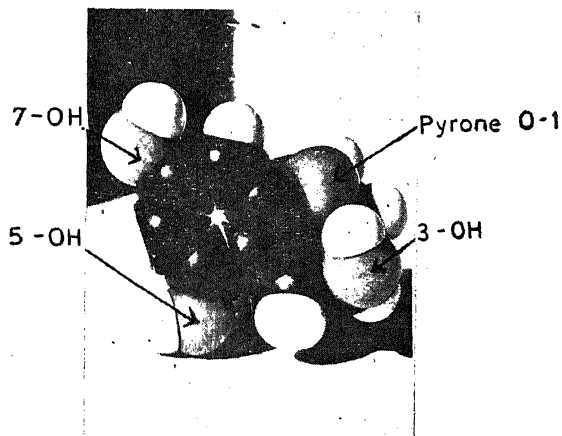


FIG. 1. Facing condensed benzene.

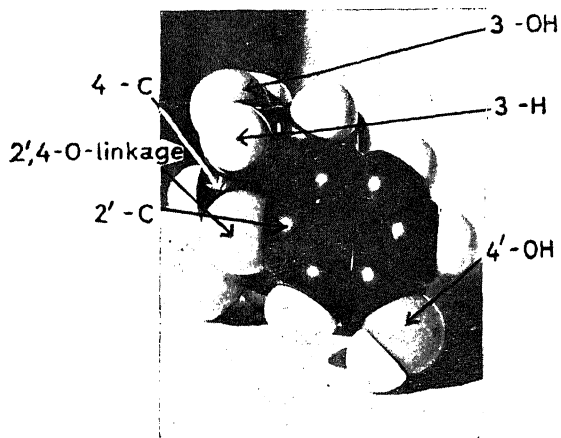
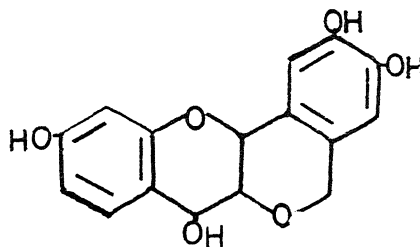


FIG. 2. Facing the side phenyl.

(e) Among the chemical properties of cyanomaclurin which favour the new structure (III) a few may be recorded here. (i) Cyanomaclurin and its methyl ether when subjected to acetylation under drastic conditions do not undergo dehydration as normally happens with

3 : 4-diols and flavan-4-ols but yield the normal acetates. As a very near example may be mentioned 5 : 7 : 4'-flavan-4-ol, which under hot acetylation condition undergoes dehydration yielding the corresponding flavene.<sup>7</sup> (ii) There seems to be some difference in solubility of hydroxyflavan derivatives depending on the presence of free hydroxyl group in the 3- or 4-positions. 3-ols like the catechins are fairly soluble in water whereas 4-ols are not. Cyanomaclurin is quite soluble in water. This behaviour is in agreement with the 3-ol structure. (iii) Attempts to convert cyanomaclurin into the corresponding tetracyclic anthocyanidin chloride have met with failure indicating the possible absence of a hydroxyl group in the 4-position. The closely related peltogynol (IV) which has a hydroxyl group in the 4-position could be converted into peltogynidin chloride<sup>8</sup> with all the rings intact.



IV

We convey our thanks to Dr. Norman S. Bhacca of Varian Associates, California, for the NMR spectrum of cyanomaclurin acetate.

1. Chakravarty, G. and Seshadri, T. R., *Tetra-Letters*, 1962, 18, 787.
2. Appel, H. and Robinson, R., *J. Chem. Soc.*, 1935, p. 752.
3. Nair, P. M. and Venkataraman K., *Tetra-Letters*, 1963, 5, 317.
4. Clerk Lewis, J. W., *et al.*, *Proc. Chem. Soc.*, 1961, p. 165.
5. Birch, A. J., *et al.*, *J. Chem. Soc.*, 1957, p. 3589.
6. Roberts, E. A. H., *Chem. and Ind.*, 1955, 631, 1551.
7. Krishnamurthy, H. G., *Ph.D. Thesis, Univ. of Delhi*, 1962.
8. Chan, W. R., *et al.*, *J. Chem. Soc.*, 1958, p. 3174.

## LETTERS TO THE EDITOR

L-FORBIDDEN TRANSITIONS NEAR  
DEFORMED REGION

RECENT work of Berlovich *et al.*<sup>1</sup> has pointed to the rather interesting connection between the l-forbidden selection rule for  $M_1$  transitions imposed by the shell model and the approach towards nuclear deformation. This conclusion was reached by Berlovich *et al.* on the basis of just three examples.

The availability of compilation of more complete data on l-forbidden  $M_1$  transitions has prompted us to examine this trend in more detail.

Table I gives an analysis of the available data. The various columns are self-explanatory.

which characterizes the onset of nuclear deformation, the  $M_1$  retardation factors decrease. The trend in the  $E_2$  enhancement and hence the surface tension parameter C cannot be discussed due to lack of data on  $M_1$ - $E_2$  mixing ratios.

Department of Physics, S. M. BRAHMAVAR.  
Karnatak University, M. K. RAMASWAMY.  
Dharwar, December 24, 1962.

1. Berlovich, E. Ye, *et al.*, *Nuclear Physics*, 1962, 37, 469
2. Bohr A. and Mottelson, B. R., *Kgl. Danske Selskab Mat. Fys. Medd.*, 1953, 27.

TABLE I

No.	Nucleus	Energy of $\gamma$ -Transition Mev.	$\delta^2 = (E_2/M_1)^2$	Conversion coeff. a	$\tau$ = lifetime (Expt.) Sec.	$M_1$ -retarda- tion factor	$E_2$ -enhance- ment	Surface-tension parameter C
1	$^{121}_{55}\text{Te}$	0.213	0.058	0.09	$< 5 \times 10^{-9}$	$> 225$	$> 0.37$	..
2	$^{133}_{55}\text{Cs}$	0.681	0.026	1.82	$6 \times 10^{-9}$	370	6	600
3	$^{129}_{55}\text{Te}$	0.159	0.012	0.19	$1.9 \times 10^{-10}$	37	8	450
4	$^{141}_{58}\text{Pr}$	0.145	0.006	0.41	$1.9 \times 10^{-9}$	330	0.44	..
5	$^{147}_{61}\text{Pm}$	0.091	0.062	1.84	$2.4 \times 10^{-9}$	220	17	290
6	$^{161}_{81}\text{Ti}$	0.330	2.24	..	$7 \times 10^{-11}$	380	15	425
7	$^{173}_{81}\text{Ti}$	0.279	2.25	0.18	$2.7 \times 10^{-10}$	920	10	580
8	$^{147}_{63}\text{Eu}$	0.295	..	0.195	$2.20 \times 10^{-10}$	115	..	..
9	$^{146}_{63}\text{Eu}$	0.150	..	0.63	$5.20 \times 10^{-10}$	78	..	..
10	$^{151}_{63}\text{Eu}$	0.217	..	29.1	$1.02 \times 10^{-7}$	47	..	..

Included in the analysis are the recent data of Berlovich *et al.*<sup>1</sup> Unfortunately, since the mixing ratio for those transitions was not given it was not possible to compute the  $E_2$  enhancements. Qualitatively, one should expect a correlation between the  $E_2$  enhancements and the approach to nuclear deformation. The last column lists the surface tension parameters C computed using the weak coupling model of Bohr<sup>2</sup> and the computed  $E_2$  enhancements. In this theory the enhancement is related to the surface tension parameter according to the relation.

$$\frac{e_{\beta\beta}}{e} = 1 + \frac{5Zk}{4\pi C}$$

where  $k$  = constant (= 40 Mev.)  
 $Z$  = atomic number.

From an examination of Table I we note that as the neutron number approaches 90,

N.Q.R. ZEEMAN SPECTRUM OF  
2, 5-DICHLORO-NITROBENZENE

THE chlorine pure quadrupole resonance lines in a single crystal of 2, 5-dichloro-nitrobenzene were reported previously.<sup>1</sup> The purpose of the present note is to report the results obtained from a detailed analysis of the Zeeman spectrum of these lines.

Single crystals of large size were grown both from melt and from saturated solution in benzene. Groth<sup>2</sup> had given the morphological data for this compound. It is a triclinic crystal with

$$a : b : c = 1.4385 : 1 : 0.8223$$

$$\alpha = 87^\circ, 18'; \beta = 114^\circ, 17'; \gamma = 82^\circ, 37\frac{1}{2}'.$$

Detailed X-ray data are not available. Preliminary X-ray analysis<sup>3</sup> shows that there are two molecules in a unit cell.

As has been observed two lines are obtained in the absence of the Zeeman field. The chlorine

which is ortho to the nitro-group Cl (1) has the higher frequency and the chlorine which is meta to the nitro-group Cl (2) has the lower frequency. Each of these lines gives a two-line pattern for most of the orientations of the Zeeman field provided by a pair of Helmholtz coils. The analysis was carried out by plotting the zero splitting locus for each line and by refining the loci by the method of least-squares. The analysis carried out for both the cylindrical crystal (grown from melt) and the crystal with faces (grown from solution) shows that:

- (1) The two molecules in the unit cell are in equivalent positions.
- (2) The chlorine nearer to the nitro-group has a larger asymmetry parameter.
- (3) The molecules are oriented in planes parallel to the cleavage plane.
- (4) There are two different field gradients—one for each chlorine. The two C—Cl bonds are not exactly collinear but there is a very small bending of one of the bonds.

From the measured asymmetry parameters, bond characters have been calculated by both molecular orbital and valence bond methods. The final results are given in Table I.

TABLE I

	Frequency	Asymmetry parameter	Percentage double bond character	Percentage single bond character	Percentage ionic character
Cl (1)	37.23 Mc/S.	0.11	4.0	81.8	14.2
Cl (2)	35.48 Mc/S.	0.09	3.0	78.1	18.8

The bond characters obtained here are in good agreement with those for related compounds. The approximate atomic positions have also been calculated. Full details will be published elsewhere.

The authors are deeply indebted to Prof. K. R. Rao for his guidance. Their grateful thanks are due to Dr. D. Premaswarup for his suggestions and to Dr. B. V. Ramana Murty for the preliminary X-ray data.

Physics Department,  
Andhra University,  
Waltair, April 15, 1963.

V. NAGARAJAN.  
C. R. K. MURTY.

1. Nagarajan, V., *Curr. Sci.*, 1962, 31, 233.
2. Groth, P., *Chemische Krystallographie*, Verlag Von Wilhelm Engelman, Leipzig, 1917, 4, 44.
3. The preliminary X-ray analysis was performed by Dr. B. V. Raman Murty of I.I.T., Madras, at our request.

## ACTIVATION OF MICROWAVE CRYSTALS AT LOW INPUT MICROWAVE POWERS BY D.C. BIASING

It is well known<sup>1</sup> that conversion loss of microwave crystals is greatest at low input powers. For this reason full advantage cannot be taken of use of microwave bridges like the hybrid E-H (or magic tee) bridge. In case the quiescent operating point of the magic-tee bridge is made zero, the crystal has low sensitivity for incoming small signals, and in case a small quiescent power is allowed to be applied to the crystal (by slight unbalance of the bridge) a high gain amplifier system cannot be used due to this quiescent output.

The difficulty mentioned above was simply overcome by properly d.c. biasing the crystal in the forward direction. Figure 1 depicts the experimental arrangement. The crystal is connected to one end of a screened transformer, the other end of which is grounded for a.c. through a capacitor C. The d.c. circuit for the crystal is completed through the transformer, the battery and the resistor.

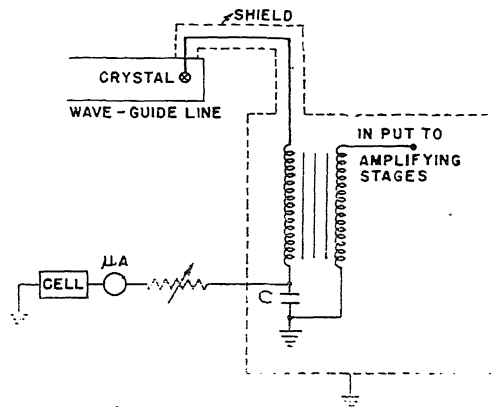


FIG. 1

It was seen that the crystal was almost fully reactivated by biasing it with the d.c. current. As the current increased, the sensitivity also increased, but so did the output noise. Experimentally a current of 50 microamperes was found to be the optimum value for common microwave crystals like the 1N 21 and 1N 23.

The capacitance of C should be big enough (500 to 1000 microfarads) due to the low impedance of the crystal and the associated transformer (about 200 ohms).

Almost all commercial voltage standing wave ratio meters incorporate input transformers in the way of Fig. 1, except that one end of the transformer is conductively returned

to ground. The end can be lifted from ground and again grounded for a.c. by a capacitor and the arrangement of Fig. 1 achieved for the purpose of activation of the microwave crystal.

Electronics Division, C. S. KUMAR.  
National Physical Laboratory, R. PARSHAD.  
New Delhi, April 29, 1963.

1. Torrey, H. C. and Whitmer, C. A., *Crystal Rectifiers*, Radiation Laboratory Series, McGraw-Hill Book Company Inc., 1948, 15.

## ALDEHYDES AS CORROSION INHIBITORS

### Part I. Inhibition of the Corrosion of Aluminium in Hydrochloric Acid by Furfuraldehyde

It appears that aldehydes and ketones are not tested as corrosion inhibitors for aluminium and its alloys in various acids. The influence of aliphatic aldehydes as inhibitors for steel in hydrochloric acid was carried out by Balezin and Kemkhadze.<sup>1</sup> Results on corrosion and inhibition of aluminium and its alloys have been published by Ramachar.<sup>2-4</sup> The present communication deals with the use of furfuraldehyde as corrosion inhibitor for aluminium in hydrochloric acid.

The corrosion rates were determined under the following conditions: (i) Size of aluminium specimen— $6 \times 3 \times .22$  cm. (ii) Concentration of hydrochloric acid—0.5, 1, 2, 5 and 10 N. (iii) Temperature— $35 \pm 0.1^\circ\text{C}$ . (iv) Immersion period—15, 30, 45, 60, 90 minutes and also for 24 hours. The efficiency of the inhibitor was investigated by adding 0.5, 1, 2, 4, 6 and 8 ml. of freshly distilled furfuraldehyde to 230 ml. of the acid. Aluminium strips were polished accordingly to the standard procedure. A small hole was drilled near the upper edge and specimens were completely immersed in solutions by glass hooks. The efficiency of the inhibitor was calculated from the weight loss. Sheets of aluminium 2S (Indal-minium 99% Aluminium) were supplied by Messrs. Indian Aluminium Co. Ltd., Calcutta. Furfuraldehyde appears to be one of the excellent inhibitors so far known for aluminium in dilute as well as in highly concentrated hydrochloric acid. The efficiency of the inhibitor, even at as low a concentration as 0.5 ml. in 230 ml. of the acid, is about 85–99%. When 2 to 4 ml. of furfuraldehyde is added to 230 ml. of the acid, the inhibitor efficiency is almost 100% under a wide variety of conditions. The efficiency of

the inhibitor does not decrease with increase in the immersion period.

Some typical results are recorded in Table I.

TABLE I

The effect of acid concentration, immersion period and inhibitor concentration on inhibitor efficiency

Conc. of HCl	Ml. of Furfuraldehyde	Inhibitor efficiency (%) for an immersion period of					
		15 min.	30 min.	45 min.	1 hr.	2 hr.	24 hr.
1 N	0.5	..	90	..	93	93	..
	1.0	..	90	..	95	96	..
	2.0	..	90	..	97	98	93
	4.0	..	90	..	97	98	96
	8.0	..	83	..	93	95	82
	8.0	..	83	..	93	95	82
2 N	0.5	99	99.5	99.5	99.5	..	..
	1.0	99	99.5	99.6	99.7	..	..
	2.0	99	99.5	99.6	99.7	..	..
	4.0	98	99.5	99.5	99.6	..	..
	8.0	97	98.7	98.5	98.4	..	..
	8.0	97	98.7	98.5	98.4	..	..

It is interesting to note that there is a reduction in the protective action of furfuraldehyde above a concentration of 4 ml. in 230 ml. of the acid. The falling-off of protective power may be explained by the suggestion that aldehydes can be reduced to alcohols and act as hydrogen acceptors. It may be stated that with rising concentrations of furfuraldehyde, there is in addition to the diminution of corrosion, a growing opposite effect due to the action of furfuraldehyde as a depolarizer of hydrogen. It must be remembered here, however, that a falling-off of protective power with rising concentration of inhibitor is also shown by other inhibitors which are incapable of depolarizing hydrogen.

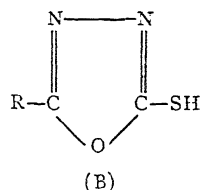
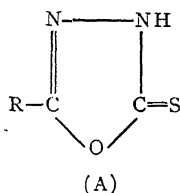
Thanks of the authors are due to Messrs. Indian Aluminium Co. Ltd., Calcutta, for the supply of aluminium sheets. Thanks are also due to Dr. B. K. Vaidya, for his keen interest in the work.

Chemistry Department, M. N. DESAI.  
Univ. School of Sciences, (MRS.) S. M. DESAI.  
Gujarat University,  
Ahmedabad-9, December 4, 1962.

1. Kemkhadze, V. S. and Balezin, S. A., *Zh. obshchei khim.*, 1955, 22, 1848.
2. Ramachar, T. L., Sundararajan, J., *Proceedings of the First International Congress on Metallic Corrosion*, London, 1961, 468.
3. — and —, *Corrosion—National Association of Corrosion Engineers*, 1961, 17, 111.
4. — and Sheth, K. G., *Australian Corrosion Engineering*, 1961, 5 (12), 15.

# SUBSTITUTED OXADIAZOLE-2-THIONES

A SERIES of 5-substituted-1,3,4-oxadiazole-2-thiones were synthesized for the study of their anti-tubercular and antibacterial properties. These compounds have been given the thione structure (A) instead of the thiol structure (B),<sup>1</sup> though in the mildly alkaline solutions with which the pharmacological tests are conducted the latter type might come into consideration.



R	m.p.	m.p. (lit.)
I <i>o</i> -H <sub>2</sub> N-C <sub>6</sub> H <sub>4</sub> -	235-37°	
II <i>p</i> -H <sub>2</sub> N-C <sub>6</sub> H <sub>4</sub> -	228-30°	
III 3-pyridyl-	234-36°	235-37° <sup>1</sup>
IV 4-pyridyl-	264-66°	272° <sup>2</sup> , 264-65° <sup>3</sup>
V <i>o</i> -Cl-C <sub>6</sub> H <sub>4</sub> -	188-90°	
VI C <sub>6</sub> H <sub>5</sub> -	224-25°	219-20° <sup>2</sup>
VII <i>o</i> -H <sub>2</sub> NSO <sub>2</sub> -C <sub>6</sub> H <sub>4</sub> -	191-92° ( <i>d.</i> )	
VIII <i>o</i> -HO-C <sub>6</sub> H <sub>4</sub> -	209-10°	212-13° <sup>4</sup>
IX <i>o</i> -CH <sub>3</sub> O-C <sub>6</sub> H <sub>4</sub> -	231-32°	223-26° <sup>1</sup>
X -CH <sub>2</sub> ·CH <sub>2</sub> ·S·CH <sub>2</sub> ·CH <sub>2</sub> -	168-70°	
XI <i>p</i> -O <sub>2</sub> N-C <sub>6</sub> H <sub>4</sub> -	200-02°	207-09° <sup>1</sup>
XII <i>o</i> -HS-C <sub>6</sub> H <sub>4</sub> -	205-07°	
XIII	167-70°	

The compounds were prepared by condensing the corresponding acid hydrazides with carbon disulphide in the presence of pyridine at 70-80°. It was found that under the reaction conditions the S-S linkage of diphenyl disulphide-*o*, *o'*-dicarboxylic acid dihydrazide cleaved to yield 5-*o*-mercaptophenyl-1, 3, 4-oxadiazole-2-thione (XII), which was also obtained from *o*-mercapto-benzoic acid hydrazide by the usual procedure. The compound (XIII) was prepared by oxidation of (XII) with hydrogen peroxide in methyl ethyl ketone.

In view of the reported fungicidal activity of the derivatives of diphenyl disulphide-*o*, *o'*-dicarboxylic acid dihydrazide,<sup>5</sup> compounds (XII) and (XIII) are being screened for their antifungal properties also. The pharmacological tests are in progress.

Research and Development Division,  
Sarabhai Chemicals,  
Baroda, May 7, 1963.

V. S. DIGHE.  
G. BAGAVANT.  
S. SOMASEKHARA.  
S. L. MUKHERJEE.

1. Ainsworth, C., *J. Amer. Chem. Soc.*, 1956, **78**, 4475.
2. Young, R. W. and Wood, K. H., *Ibid.*, 1955, **77**, 400.
3. Yoshida, S. and Asai, M., *J. Pharm. Soc. Japan*, 1954, **74**, 946 (*C.A.*, 1955, **49**, 10938).

4. Baron, M. and Wilson, C. V., *J. Org. Chem.*, 1958, **23**, 1021 (*C.A.*, 1959, **53**, 15065).
5. Katz, L., Karger, L. S., Schroeder, W. and Cohen, M. S., *Ibid.*, 1953, **18**, 1380 (*C.A.*, 1954, **48**, 12031).

## NATURALLY OCCURRING ANHYDROVITAMIN A<sub>2</sub>

It has been found that when a vitamin A<sub>1</sub> concentrate is treated with alcoholic hydrogen chloride, three sharp bands appear at 350, 369 and 392 mμ.<sup>1</sup> The product so formed was called "cyclised" vitamin A because it was thought that it was obtained by bending of the polyene chain followed by the closure of the ring with the formation of a naphthalenic compound. Shantz et al.<sup>2</sup> isolated this product in a crystalline form by following exactly the same

procedure as elaborated by Edisbury *et al.*<sup>1</sup> and purifying the product further by chromatography on alumina. It was found that the "cyclised" product passes quickly through the column as a rapidly moving greenish-yellow band. The product was crystallised from petroleum ether as clusters of orange prisms showing ultra-violet absorption maxima at 351, 371 and 396  $m\mu$  and antimony trichloride colour maximum at 620  $m\mu$ .

Shantzi<sup>2</sup> and Cama *et al.*<sup>4</sup> found that when vitamin  $A_2$  was similarly treated with ethanolic hydrogen chloride, a substance was produced with the same absorption peaks as those of anhydrovitamin  $A_1$  but in the antimony trichloride colour test it gave an absorption maximum at 693  $m\mu$ . These anhydrovitamins  $A_1$  however, may not be similar in structure since their adsorption affinities on a chromatographic column and their  $SbCl_3$  colour maxima are different. Henbest *et al.*<sup>5</sup> have shown that anhydrovitamin  $A_2$  is 4-ethoxy anhydrovitamin  $A_1$ . Cama and his colleagues<sup>6</sup> have shown that anhydrovitamin  $A_2$  fed to rats is transformed into a new compound rehydrovitamin  $A_2$ . They have recently also determined<sup>7</sup> the biopotency of crystalline anhydrovitamin  $A_2$  and have shown that anhydrovitamin  $A_2$  which contains a 4-ethoxy group, when fed to rats, is deposited in the liver as rehydrovitamin  $A_2$  where the 4-ethoxy group is probably absent.

The occurrence of anhydrovitamin  $A_1$  in fish liver oils has led to views whether it is present naturally or is produced as an artifact during the chemical manipulation of vitamin  $A$ .<sup>8</sup> However, anhydrovitamin  $A_1$  is found to occur naturally in some fish liver oils.

Cama and his colleagues<sup>6</sup> have recently claimed to be the first to report the occurrence of naturally occurring anhydrovitamin  $A_2$  in the liver oil of *Wallago attu*, a freshwater fish of India. That this substance is initially present in the oil and not formed as a result of heat treatment during extraction was proved by chromatography of the cold-extracted oil. In this note we report the presence of anhydrovitamin  $A_1$  occurring naturally in the liver oil of the freshwater fish *Bagarius bagarius*, thus confirming the earlier observation of Cama and his colleagues<sup>6</sup> that anhydrovitamin  $A_2$  was not an artifact.

*Bagarius bagarius* is a freshwater fish found in the inland waters of Assam in North-eastern India. The minced liver of this fish was extracted in the cold with petroleum ether (40°-60°) after grinding it with acid-washed silver sand and anhydrous sodium sulphate and

the extract concentrated under reduced pressure, the last traces of solvent being driven off in a stream of nitrogen. The temperature was always kept under 45° C. A portion of the reddish-brown oil thus obtained was chromatographed on a column of weakened alumina (5% water) following the procedure detailed by Barua and Morton.<sup>9</sup> Eight different fractions were collected. The zones sticking to the column were eluted by using mixtures of ether and petroleum ether, gradually increasing the ratio of ether : petroleum ether concentration. With 10 : 90 ether : petroleum ether mixture it was possible to get a fraction showing absorption maximum at 352, 371 and 392  $m\mu$  with an inflexion at 333  $m\mu$  (Fig. 1). With antimony

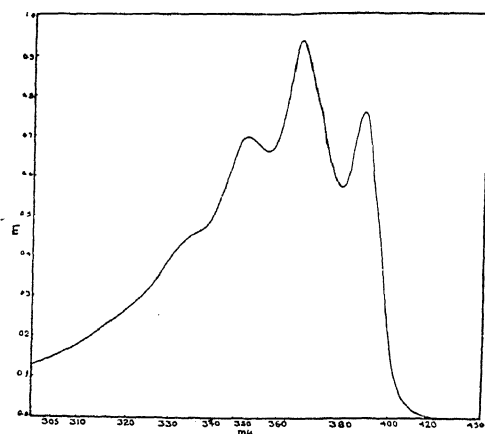


FIG. 1. Ultra-violet absorption spectrum of naturally occurring anhydrovitamin  $A_2$  (reproduced from Beckman self-recording Spectrophotometer Chart;  $\lambda$  scale non-linear).

trichloride it gave a greenish-blue colour with maximum at 693  $m\mu$ . This fraction was, therefore, clearly identical with anhydrovitamin  $A_2$  as found by Cama *et al.* in the liver oil of *Wallago attu*. As the extraction was done in the cold and other operations were carried out under 45° C., the product obtained could not be an artifact but a substance naturally occurring in the liver oil. Further work is in progress to study and characterise the other fractions.

Our thanks are due to the Council of Scientific and Industrial Research which has sponsored this scheme.

Organic Chemistry  
Laboratory,

Gauhati University, February 27, 1963.

R. K. BARUA,

P. G. NAYAR.

1. Edisbury, J. R., Gillam, A. E., Heilbron, I. and Morton, R. A., *Biochem. J.*, 1932, 26, 1164.



2. Shantz, E. M., Cawley, J. D. and Embree, N. D., *J. Am. Chem. Soc.*, 1943, **65**, 201.
3. —, *Science*, 1948, **108**, 417.
4. Cama, H. R., Dalvi, P. D., Morton, R. A., Salah, M. K., Steinberg, G. R. and Stubbs, A. L., *Biochem. J.*, 1952, **52**, 540.
5. Henbest, H. B., Jones, E. R. H. and Owen, T. C., *J. Am. Chem. Soc.*, 1955, pp. 2763.
6. Balasundaram, S., Bamji, M. S., Cama, H. R., Sundaresan, P. R. and Varma, T. N. R., *J. Biol. Chem.*, 1958, **223**, 827.
7. Bamji, M. S., Cama, H. R. and Sundaresan, P. R., *Ibid.*, 1962, **237**, 2747.
8. Moore, T., *Vitamin A*, Elsevier Publishing Co., 1957, p. 117.
9. Barua, R. K. and Morton, R. A., *Biochem. J.*, 1949, **45**, 308.

## STUDIES IN TERPENES

## Part XIV. Action of Alcoholic Sulphuric Acid on 3-Carene

ACCORDING to Krupowicz<sup>1</sup> when *d*-3-carene is refluxed with 10% ethanolic sulphuric acid and catalytic amounts of anhydrous magnesium sulphate, an optically inactive mixture containing  $\alpha$ -terpinene and 3, 8 (9)-*p*-menthadiene is obtained. The identification of these products was based on their oxidation with alkaline potassium permanganate to  $\alpha$ ,  $\alpha'$ -dihydroxy- $\alpha$ -methyl- $\alpha'$ -isopropyl adipic acid (I) and  $\beta$ -methyladipic acid (II) respectively. Since the conversion of 3-carene to 3, 8 (9)-*p*-menthadiene is a unique rearrangement among bicyclic terpenes, it is of interest to confirm this observation and to ascertain whether the reaction results in other hydrocarbon derivatives also.

## EXPERIMENTAL\*

Concentrated sulphuric acid, 10 g. (0.10 mol.) was dissolved in absolute ethanol, 90 g., contained in a 500 ml. two-necked flask fitted with a reflux condenser carrying a calcium chloride guard tube and a thermometer reaching into the reaction mixture. 3-carene, 136 g. (1 mol.) and 1 g. anhydrous magnesium sulphate were added and the mixture refluxed for 10 hr., the temperature being maintained at 83–85° by means of a Glas-col heating mantle. The reaction mixture was cooled to room temperature, neutralised with 10% sodium hydroxide solution and steam-distilled. The volatile oil obtained was washed repeatedly with water to ensure complete removal of ethanol and dried over anhydrous magnesium sulphate [yield 89.2% ;  $n_D^{20}$  1.4872,  $d_4^{20}$  0.8540, ( $\alpha$ )<sub>D</sub><sup>20</sup> +1.69°]. A portion of this oil (68 g.) was fractionally distilled in Todd Precise Fractionation Assembly at a reflux ratio 50:1, using 90 cm./5 mm. column with Monel spiral packing and the various cuts were analysed (Table I).

That 3-carene has not undergone complete change was chemically confirmed by the preparation from cut 1 (1.5 g.) of a nitrosate melting at 147.5° (decomp.)<sup>2,3</sup> (yield ca 15 mg.).

The main product of the reaction,  $\alpha$ -terpinene, was identified by the preparation of the nitrosite, m.p. 155°,<sup>4</sup> utilising the method earlier recommended.<sup>5</sup> Cuts 2, 3 and 4, each 850 mg.,

\* Mixture melting point determinations of derivatives showed no depression of melting points unless otherwise stated.

TABLE I  
Analytical data of steam volatile oil

Cut	b.p. °C./736 mm.	Total distillate %	$n_D^{20}$	Wallach's Test	Hydrocarbons identified
1	169–171	2.9	1.4718	Purple to blue	3-Carene
2	171–173	3.1	1.4736	Transient blue	$\alpha$ -Terpinene
3	173–175	15.6	1.4744	do.	$\alpha$ -Terpinene <i>p</i> - and <i>m</i> -Cymenes
4	175–178	8.9	1.4771	do.	$\alpha$ -Terpinene <i>p</i> - and <i>m</i> -Cymenes
5	178–181	12.2	1.4799	do.	$\alpha$ -Terpinene Dipentene
6	181–184	16.7	1.4869	do.	3, 8 (9)- <i>p</i> - menthadiene
7	184–188	20.0	1.4900	Intense blue	
8	188–195	3.3	1.4682	No characteristic colour	
9	195–196	4.4	1.4631	No colour	
10	Residue steam distilled	6.6	1.4680	No characteristic colour	

furnished about 350, 260 and 250 mg., of  $\alpha$ -terpinene nitrosite respectively. In cut 5 (5 g.), however, it could be recognised only by degradative oxidation<sup>1,6</sup> to the substituted adipic acid (I) m.p. 187° (yield ca 20 mg.).

Dipentene was shown to be present in cut 5 by the preparation of its nitrosochloride. A solution consisting of cut 5 (850 mg.), amyl nitrite (1.5 g.) and glacial acetic acid (2.5 ml.) was cooled in ice-salt bath. After dropwise addition of a mixture of conc. hydrochloric acid and glacial acetic acid (1:1, 2.8 ml.) it was chilled for 30 mts. and then cold methanol (3 ml.) was added. When the reaction mixture was allowed to stand for 12 hr. at 0-5° crystals were formed, in ca 30 mg. yield. These were washed with cold methanol (2 ml.) and reprecipitated from chloroform solution by addition of cold methanol. The analytical sample of nitrosochloride obtained melted at 105-5° (Reported value 104°<sup>8</sup>).

The cuts 3 and 4 together provided after treatment with sulphuric acid<sup>9,10</sup> ca 5% of a saturated oil,  $N_D^{20}$  1.4906. The oxidation<sup>11</sup> of this oil gave terephthalic acid and isophthalic acid in amounts equivalent to 45% *p*-cymene and 38% *m*-cymene respectively; these dicarboxylic acids were further characterised by conversion into their dimethyl esters.<sup>12,13</sup>

When oxidised with alkaline potassium permanganate,<sup>1</sup> cut 6 (5 g.) yielded ca 10 mg. of (II), m.p. 95-96°, thus confirming the earlier finding of Krupowicz.<sup>1</sup> From the small yield of (II) it would appear that hydrocarbon derivatives other than 3.8(9)-*p*-menthadiene were also present in this fraction. The colour test with Wallach's reagents, viz., acetic anhydride-conc. sulphuric acid, indicated the presence of *m*-compounds.<sup>14,15</sup> No derivatives of  $\alpha$ -terpinene could be prepared from this cut. However, a bromide of m.p. 117° which was depressed on admixture with either terpinolene or dipentene tetrabromide was obtained.

This study has therefore confirmed the formation of 3.8(9)-*p*-menthadiene and  $\alpha$ -terpinene from 3-carene by Krupowicz's reaction.<sup>1</sup> Moreover, the presence of unreacted 3-carene, dipentene, *p*-cymene, *m*-cymene and *m*-compounds responding to Wallach's colour test in the reaction mixture has been demonstrated. Thus, in conformity with the general behaviour of 3-carene<sup>2,9,16</sup> the cyclopropane ring undergoes two-way cleavage giving rise to *p*- and *m*-derivatives.

Dept. of Chemistry, K. K. SUGATHAN.  
Christ. Medical College, C. PUNNOOSE MATHEW.  
Vellore, March 4, 1963. JAMES VERGHESE.

1. Krupowicz, J., *Studia Soc. Sci. Torunensia (Torun) Sect. B. (Chem.)*, 1954, **1** (2), 1; *Chem. Abstracts*, 1957, **51**, 295.
2. Simonsen, J. L., *J. Chem. Soc.*, 1920, **117**, 570.
3. —, *The Terpenes*, Cambridge University Press, 2nd Edn., 1957, **2**.
4. Wallach, O., *Ann.*, 1887, **239**, 35.
5. Sugathan, K. K. and Verghese, J., *J. Ind. Chem. Soc.*, 1963, **40**, 91.
6. Guenther, E., *The Essential Oils*, D. Van Nostrand Company, Inc., New York, 3rd Edn., 1957, **2**.
7. Cf. Wallach, O., *Ann.*, 1908, **362**, 297.
8. Wallach, O., *Ibid.*, 1892, **270**, 175.
9. Verghese, J. and Yeddnapalli, L. M., *J. Sci. & Ind. Res.*, 1953, **12B**, 121.
10. Pines, H., Olberg, R. C. and Ipatieff, V. N., *J. Amer. Chem. Soc.*, 1952, **74**, 4872.
11. Xavier, L. M., Verghese, J. and Yeddnapalli, L. M., *Curr. Sci.*, 1953, **22**, 112.
12. Huntress, E. H. and Mulliken, S. P., *Identification [of Pure Organic Compounds, Order I]*, Chapman & Hall, Ltd., London, 1946.
13. Smith, M. E., *J. Amer. Chem. Soc.*, 1921, **43**, 1921.
14. Wallach, O., *Ann.*, 1885, **230**, 240; 1887, **239**, 4.
15. Bardyshev, I. I., *Dok. Akad. Nauk. SSSR*, 1953, **90** (6), 1035.
16. — and Efimenko, V. L., *Doklady Akad. Nauk. Beloruss SSR*, 1959, **3** (4), 150; *Chem. Abstract*, 1960, **54**, 1539; Ivermark, R. F., (to Bergvik and Ala Naya Aktiebolag), *Swed. Pat.*, Nov. 25, 1952, **138**, 156; *Chem. Abstracts*, 1954, **48**, 1440; *Ger. Pat.*, June 14, 1956, **944**, 489; *Chem. Abstracts*, 1959, **53**, 3271.

## THE RESOLUTION OF (±) MANDELIC ACID

(±) MANDELIC ACID has been efficiently resolved into its (+) and (−) isomers by fractional crystallisation of its cinchonine salts from a mixture of acetone-chloroform (2 : 1).

(+) and (−) mandelic acids (m.p. 132-33°); ( $\alpha$ )<sub>D</sub><sup>20</sup> + 156°, m.p. 133-34°, ( $\alpha$ )<sub>D</sub><sup>20</sup> − 158° respectively have been obtained up to 70% of the theoretical yield.

Dextrorotatory mandelic acid was obtained by Lewkowitsch<sup>1</sup> by the use of penicellium glaucum and later by means of a nucleus of cinchonine (+) mandelate; for the preparation of (−) mandelic acid he employed *Saccharomyces ellipsoideus*.

During the intervening years numerous descriptions have been published for obtaining (+) and (−) mandelic acids by use of many different alkaloids, and also ephedrins—thus implying that no really efficient method of resolution has been found. It is somewhat remarkable that the only solvent used for the fractional crystallisation of these various salts has been water.

McKenzie<sup>2</sup> and Rimbach<sup>3</sup> independently resolved (±) mandelic acid by different alka-

loids—cinchonine, cinchonidine, brucine, quinine, quinidine and morphine in aqueous solutions but eventually they suggested natural amygdalin as a convenient source of (–) mandelic acid. Most of the later workers followed McKenzie's method.

Wood, Chrisman and Nicholas<sup>1</sup> recommended morphine for resolution of (±) mandelic acid from alcohol (60%). Levene and co-workers<sup>2</sup> employed (–) ephedrine for preparation of (–) mandelic acid on suggestion of Richard and Johnson.<sup>3</sup>

Johnson<sup>4</sup> and Skita, Keil and Meiner<sup>5</sup> resolved mandelic acid by means of both optically active forms of ephedrine from absolute alcohol.

It is now found that the alkaloid used for this purpose cinchonine proves very effective when its salt with mandelic acid is fractionally crystallised not from water but from a mixture of acetone and chloroform. It has been found further that an increase in the proportion of cinchonine, i.e., more than one molecular amount, gives a larger yield of optically pure mandelic acid.

**Preparation of Cinchonine Mandelates.**—To (±) mandelic acid (50 g.; 1 mol.) dissolved in acetone (100 ml.) added a solution of cinchonine (125 g.; 1.25 mol.) in chloroform (150 ml.) and warmed. The clear solution on standing for one hour started depositing the less soluble cinchonine mandelate, and the whole of it separated after keeping overnight (74.5 g.; m.p. 173–75°). After three crystallisations from chloroform-acetone (1 : 2) it had m.p. 179–80° (71.25 g.; 95%).

The filtrate did not deposit any more salt even after a week. The mother liquors were combined with the filtrate and concentrated to 100 ml. and mixed with acetone (50 ml.). After keeping overnight it started depositing the more soluble cinchonine mandelate and continued depositing the salt for four days until a viscous solution was left behind which did not give any crystals even after keeping for a month. The more soluble cinchonine mandelate (73.6 g.; m.p. 158–61°) after three crystallisations from acetone had m.p. 165–66° (59.8 g.; 79.8%).

Wood, Chrisman and Nicholas<sup>1</sup>: m.p. 176–77°; 165–66°. McKenzie<sup>2</sup>: m.p. 79–80°; 165–66°.

**Liberation of Optically Active Mandelic Acids.**—The less soluble cinchonine mandelate (70 g.) was made into paste with acetone (15 ml.) and decomposed with ice-cold hydrochloric acid (1 : 1) until the resulting solution was just acidic to congo red. Diluted the solution to one litre and extracted twice with ether (750 ml.). Removed cinchonine from aqueous solution with ammonia and extracted the aqueous filtrate

again with ether (750 ml.) after acidifying with dilute hydrochloric acid.

The combined ether extracts were washed with water, dried and the solvent distilled off. (–) Mandelic acid (22.4 g), m.p. 124–29°; after three crystallisations from acetone-benzene had m.p. 133–34° (16.3 g.; 69.9%).

The mother liquors on evaporation left behind (±) mandelic acid (7.32 g.), m.p. 118° C.

Similarly the more soluble cinchonine mandelate (58.1 g.) yielded (±) mandelic acid (12.8 g.; 65.3%), m.p. 132–23° ( $\alpha_D^{25} + 156^\circ$  (1 : 1) and (±) mandelic acid (9.2 g.; m.p. 118° ( $\alpha_D^{25} \pm 0.00$ ).

McKenzie<sup>2</sup> ( $\alpha_D^{25} - 159.7^\circ$  Ward Chrisman and Nicholas<sup>1</sup> ( $\alpha_D^{25} - 157.2^\circ$  (C 2.01, l 2); – 143.3°.

This work was carried out in the Chemistry Department, Battersea College of Technology, London, S.W.1.

Chemistry Department,

J. L. NORULA.

College of Engineering and

J. KENYON.

Technology, Hauz Khas,

New Delhi-16, December 21, 1962.

1. Lewkowitsch, *Ber.*, 1883, **16**, 1569.
2. McKenzie, *Jour. Chem. Soc.*, 1904, **85**, 380.
3. Rimbach, *Ber.*, 1889, **32**, 2385.
4. Wood, Chrisman and Nicholas, *Jour. Chem. Soc.*, 1928, **131**, 2180.
5. Levene and Co-workers, *J. Biol. Chem.*, 1932, **97**, 379; 1935, **112**, 195; 1937, **118**, 315.
6. Richard and Johnson, *Jour. Amer. Chem. Soc.*, 1929, **51**, 1906, 1909.
7. Skita, Keil and Meiner, *Ber.*, 1933, **66**, 974.

#### PROTEASE AND DIASTASE ACTIVITY IN THE ROOTS OF PLUMBAGO ZEYLANICA LINN.

A NUMBER of plants have been reported in the literature for the presence of protein-splitting enzyme and diastatic activity.

The protease activity in plants, which produces latex, is well known. Reports on proteases in the green leaves of plants, which do not produce latex are comparatively few. Greenberg and Winnick<sup>1</sup> list eleven plant proteases from different sources, such as fruits and green leaves of pineapple. Tracey<sup>2</sup> lists leaf proteases of thirteen plants including tobacco. There is hardly any reference to the presence of protein-splitting enzyme in the roots of plants used in medicine.

The plant *P. zeylanica* has been in use in Indian Medicine for centuries as a "Deepaniya", meaning stimulating the processes of digestion and metabolism. Plumbagin, one

chemical constituent, has been isolated<sup>3</sup> and even synthesized.<sup>4</sup> It has never been administered internally, being an irritant substance, although the total drug *P. zeylanica* is being administered even now for its alleged properties by Indian physicians in the form of an infusion. Studies, conducted by the present authors<sup>5</sup> on the gastro-intestinal flora of mice and rats as regards the effect of the roots on *E. coli* as an indicator organism, reveal that the counts of *E. coli* increase after the administration of the drug. This is significant in the light of the fact that *E. coli* is a useful saprophyte in the gastro-intestinal tract. In view of the fact that it is used as "Deepaniya" by the Indian physicians, the study on the contents of protein and starch-splitting enzymes was undertaken in this laboratory.

Air-dried roots of the plant were used, collected by the authors, round about Poona (India). Fifty grams of the powdered drug was extracted with 250 ml. of water, containing 25 ml. of  $\text{PO}_4$  buffer (0.2 M) pH-7 by churning in Waring blender for about 30 minutes. The extract was centrifuged in cold. The liquid was precipitated with alcohol. The precipitate was centrifuged in cold and dried in a vacuum desiccator. Thus the dried and partially purified enzyme powder weighed 500 mg.

Kunitz's<sup>6</sup> method for the estimation of proteases was followed. Hammarsten's casein was used as substrate for testing the proteolytic activity of the crude enzyme. Control and trial samples were prepared by taking 2 ml. of 1% enzyme extract with 2 ml. of 1% casein. The enzyme in the control samples was inactivated by adding 6 ml. of 5% trichloroacetic acid. Both the control and the trial samples were incubated at 37° C. for 30 minutes. Six ml. of 5% trichloroacetic acid was added to the trial sample after this period, and the samples were allowed to settle for half an hour. The supernatant liquid, containing free amino-acids, was taken in proper dilutions for spectrophotometric readings. The specific activity of the protease was estimated as 0.00018 units/mg. of protein.

The method described by Sumner and Howell<sup>7</sup> for the estimation of invertase was followed. Sucrose was used as a substrate for the estimation of invertase. Control and trial samples were prepared by taking 1 ml. of 6.5% sucrose to which was added 1 ml. of 1% enzyme extract. Dinitrosalicylic acid was used to inactivate the enzyme in the control sample. Both the control and trial samples were incubated at 37° C. for half an hour. Two ml. of 1:3-dinitrosalicylic acid was added to the trial

samples after this period. The control and the trial samples were then heated for 5 minutes on a boiling water-bath and cooled under running tap-water. Twenty ml. of distilled water was added to both the samples. With these dilutions the samples were taken for reading in the Klet's Sommerson Colorimeter. The specific activity of the invertase was estimated as .043 units/mg. of proteins. Attempt was made to detect the presence of amylase also in the crude enzyme by using soluble starch as a substrate. However, no amylolytic activity was detected. The pharmacognostic study<sup>8</sup> also indicated the presence of glucose and fructose in appreciable quantities in the root.

The estimation of the enzymatic activity in the fresh and old samples of the drug is in progress. The relationships of the content of the enzyme to pH, temperature and storage are being studied. The fact that *E. coli* concentration in the gastro-intestinal tract increases after the administration of the drug and also the detection of proteolytic and diastatic enzymes together with the presence of sugar indicate the usefulness of the total drug as one stimulating the digestive processes. The traditional use of the drug in Indian System of Medicine as stimulating digestion, therefore, appears to have some rationale behind it.

The Indian Drugs Research. M. A. IYENGAR.  
Association Laboratory, G. S. PENDSE.  
Shivajinagar, Poona-5, December 28, 1962.

1. Greenberg, D. M. and Winnick, T., *Ann. Rev. Biochem.*, 1945, **14**, 31.
2. Tracey, M. V., *Biochem. J.*, 1948, **42**, 281.
3. Dulong D' Astafort, *J. Pharm. Sci. access*, Paris, 1829, **14**, 441.
4. Fieser, L. F. and Dunn, J. T., *J. Am. Chem. Soc.*, 1936, **58**, 572.
5. Pendse, G. S. and Iyengar, M. A., *Effect of Plumbago zeylanica Root on the Gastro-intestinal E. coli of Animals* (under publication).
6. Kunitz, M., *J. Gen. Physiology*, 1947, **30**, 291.
7. Sumner, J. B. and Howell, S. F., *J. Bio. Chem.*, 1935, **108**, 51.
8. Iyengar, M. A. and Pendse, G. S., *Indian J. Pharm.*, 1962, **24**, 290.

#### ACCURATE EVALUATION OF LATTICE PARAMETERS OF $\alpha$ -BRASSES

CONSIDERABLE attention has been paid in the past<sup>1-4</sup> to the determination of lattice parameters of  $\alpha$ -brasses in view of their intrinsic theoretical importance as well as their usefulness in establishing the  $\alpha/\alpha + \beta$  phase boundary in the copper-zinc system. The earlier investigations have not, however, been very accurate. Only in the most recent work,<sup>6</sup>

maximum accuracy has been attained, but in this case only two brasses of high zinc content were investigated. The present evaluations, which were undertaken in a study of equilibrium in copper-zinc alloys below 300° C., have all been based on the graphical extrapolation method due to Nelson and Riley<sup>6</sup> employed in the latest work and can be considered the most accurate and comprehensive so far.

$\alpha$ -Brasses containing about 10%, 20%, 30% and 35% zinc respectively by weight were chill cast to 1" diameter cylinders by melting electrolytic copper (99.99% pure) and adding B.D.H. Analar Zinc (99.99% pure) in the required quantities. These were forged at 750° C. and homogenised at 650° C. for 8 hours. Filings (-300 mesh) prepared from the massive samples were sealed in pyrex tubes under vacuum and annealed for 6 hours at 350° C. The zinc content in annealed filings was obtained by quantitative chemical analysis.

TABLE I

Lattice parameters of copper and  $\alpha$ -brasses obtained with the Nelson-Riley extrapolation

No.	Specimen	Lattice parameter ( $k \times$ Units)
1	Pure Copper	3.6073 <sub>6</sub>
2	$\alpha$ -Brass 11.41% Zinc At. %	3.6327 <sub>1</sub>
3	" 19.26% "	3.6515 <sub>7</sub>
4	" 28.71% "	3.6721 <sub>8</sub>
5	" 33.56% "	3.6898 <sub>7</sub>

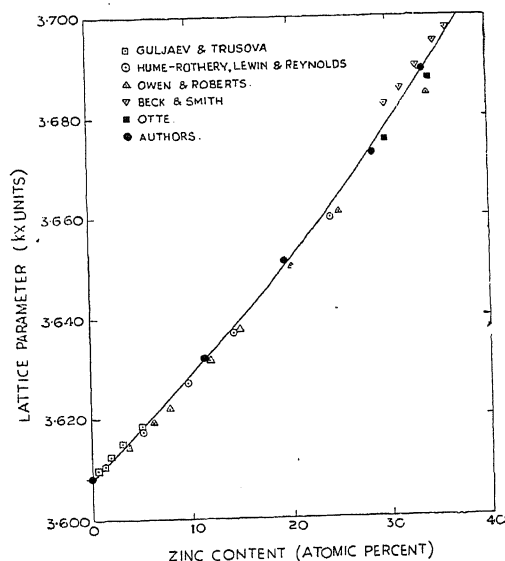


FIG. 1. Comparison of lattice parameters of  $\alpha$ -brasses obtained by different workers.

X-ray diffraction patterns of the four annealed  $\alpha$ -brasses and annealed electrolytic copper powder (-300 mesh) were obtained in a Unicam 19 cm. camera with filtered Copper radiation. The camera constants were determined by using superpurity aluminium ( $a = 4.0490 \text{ \AA}$ )<sup>7</sup> annealed in vacuum for 6 hours at 300° C. The lattice parameters obtained from the Debye-Scherrer patterns with the Nelson-Riley extrapolation are given in Table I.

Figure 1 shows that these lattice parameters agree reasonably well with those of all earlier workers except Beck and Smith<sup>4</sup> and that they display a slight negative deviation from Vegard's law.

Dept. of Metallurgy, S. SRINIVASA RAO.  
Banaras Hindu Univ., T. R. ANANTHARAMAN.  
Varanasi-5, April 26, 1963.

1. Guljaev, A. P. and Trusova, E. F., *Zhur. Tekh. Fiz.*, 1950, 20, 66.
2. Hume-Rothery, W., Lewin G. F. and Reynolds, P. W., *Proc. Roy. Soc. London*, 1936, 157A, 167.
3. Owen, E. A. and Roberts, E. W., *Phil. Mag.*, 1929, 27, 294.
4. Beck, L. H. and Smith, C. S., *Trans. Amer. Inst. Min. Met. Eng.*, 1952, 194, 1079.
5. Otte, H. M., *J. Appl. Phys.*, 1962, 33, 1436.
6. Nelson, J. B. and Riley, D. P., *Proc. Phy. Soc. (London)*, 1945, 57, 160.
7. Max Hansen, *Constitution of Binary Alloys*, McGraw-Hill Book Company, New York, 1958, p. 1265.

### SLEROTIIDS IN THE KARGALI COALS OF EAST BOKARO COALFIELD, BIHAR

SLEROTIIDS have been observed in a few samples of the Kargali seam of Quarry No. 2 in the Bokaro coalfield.<sup>1</sup> According to *A Glossary of Botanic Terms* by B. D. Jackson, 1916, a sclerotoid may be defined as a substance that although structureless, resembles or possibly represents a compact mass of fungal hyphae in a dormant state. The occurrence of such bodies in coal, however, was first reported by Hacquebard<sup>2</sup> who described these sclerotoids as ball-shaped bodies which have certain likeness with sclerotia but do not have the typical structure present therein.

Although fungal tissues have been described from various Indian coals, Tertiary as well as Palaeozoic (Chandra<sup>3</sup>; Ganju<sup>4,5</sup>; Pareek<sup>6</sup>), sclerotoids have not been reported so far by any worker in India. In the present study sclerotoids were first suspected in thin sections under transmitted light but owing to greater opacity of opaque bodies, no structural details, excepting the form, could be discernible. As

the blocks of coal are usually preserved after thin sections are made out of these, it was decided to study the corresponding polished surface of all the respective blocks under reflected light. By this method, using an oil immersion objective, structural details of all such opaque bodies became clearly noticeable as shown in Figs. 1 and 2. These bodies are rounded to slightly elongated and are mixed in a mass of durain with coal constituents that are related to woody parts of the original



FIGS. 1-2. Ball shaped and elongated bodies of Sclerotoids are shown mixed in a mass of durain. (Polished surface Mag.  $\times 340$ .)

vegetation. They are further characterized by great hardness, that cause a very pronounced

relief in polished section with fibres of vitrinite often turning sharply round them.

As is evident from the figures there are two types of sclerotoids in these coals. The first type are those which are rounded in form and carved into chambers as shown in Fig. 1 and upper-half of Fig. 2. The chambers are either complete or, sometimes, merge in the surrounding mass. The other type of sclerotoid which lies near the lower-middle margin of Fig. 2 is conspicuous by its slightly elongated form and distinct slit-like openings. Dr. Hacquebard in a private communication conveys that these bodies strongly resemble the so-called "carved" sclerotoids encountered by him in the St. Rose coal of Eastern Canada (Hacquebard<sup>2</sup>). Although these bodies have certain likeness with sclerotia, they cannot be called so unless the structure can be observed plainly. The term may resemble these fungal bodies but not necessarily complete equivalence. The origin of the sclerotoids is still a matter of speculation.

I am indebted to the late Prof. P. N. Ganju, for his guidance and to Prof. P. A. Hacquebard, Senior Geologist, Geological Survey of Canada, for his kind response and helpful comments.

Dept. of Applied Science, S. M. CASHYAP.  
College of Engg. and Tech.,  
University of Aligarh,  
Aligarh (U.P.), December 5, 1962.

1. Hughes, T. W. H., *Mem. Geol. Surv. Ind.*, 1867, 6, Pt. 2.
2. Hacquebard, P. A., *Geol. Surv. Bull. Canada*, 1951, 19, 33.
3. Chandra, D., *Jour. Geol. Min. Met. Soc. Ind.*, 1954, 26, 47.
4. Ganju, P. N., *Proc. Nat. Inst. Sci. Ind.*, 1955, 21B, 103.
5. —, *Proc. Ind. Acad. Sci.*, 1956, 44, 30.
6. Pareek, H. S., *Pol. Soc. Ind.*, 1958, 3, 214.

#### NATIVE SULPHUR IN RECENT SEDIMENTS FROM THE GODAVARI DELTA BASIN

A RECONNAISSANCE survey of the paludal deposits around a village, Pandi, situated in the centre of a tidal channel, south of the Gautami Godavari confluence, revealed the occurrence of native sulphur in recent sediments. An impenetrable jungle of mangrove swamp stretches on either side of the tidal channel, and in this, several semi-dried patches devoid of any vegetation were observed.

These barren patches contain clayey deposits and a more detailed observation revealed that this clayey material is rich in native sulphur at a depth of 6 inches from the surface, whereas

the surficial clay is free from sulphur. The sulphur occurs in the form of yellow massive concentrations perceptible to the naked eye, and under a magnifying glass the sulphur is in the form of yellow, tiny rounded particles.

The tidal channel that surrounds the village, Pandi, represents an environment with free flow of water throughout the year and the swampy area with steady depositions. During high tide, clayey material in suspension and material in solution are transported to the swamp area and clay and evaporites get deposited there.

Analysis of the silt-clay fractions of the bottom sediment from the tidal channel and the sulphur-rich sediment from the swamp for organic carbon (Method of Allison<sup>1</sup>), free sulphur and sulphate gave the results as shown in Table I.

phurated waters, etc., from fumaroles, and (3) organic matter. The low percentage of organic carbon, the comparative abundance of sulphates in sulphur-rich sample and the absence of any evidence for the presence of fumaroles or hot springs in the area indicate the possible source of sulphur to be the sulphates brought in solution. Unlike in the tidal channel, quiet conditions of deposition and periodic complete evaporation in the swamp facilitate appreciable concentration of sulphates. Ultimately sulphur might have formed by (a) reduction of sulphates and (b) oxidation of  $H_2S$  thus formed by special bacteria. This confirms<sup>2</sup> that the most favourable condition for the formation of native sulphur in a sediment is a reducing environment.

The financial assistance of the CSIR is gratefully acknowledged.

TABLE I

Sample No.	Sample location (see Fig. 1)	Colour	Sulphur	Organic Carbon	Sulphate
1*	Sample at a depth of 6" from the surface (Mangrove swamp area)	Dark greyish when wet; Light grey when dry	3.01%	0.226%	More
2*	Bottom sediment from the tidal channel	Dark greyish green when wet; Dark chocolate brown when dry	0.75%	1.947%	Much less

\* The average of four analyses.

Sulphur in a sedimentary environment can get accumulated from (1) sulphates, (2) sul-

Geology Department, A. S. NAIDU.  
Andhra University, C. BORRESWARA RAO.  
Waltair, February 14, 1963.

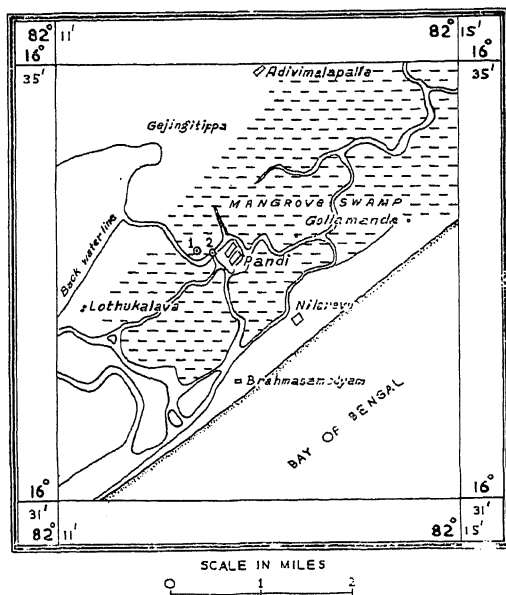


FIG. 1. Location of samples. (1) Sample from Swampy area; (2) Sample from tidal channel.

1. Allison, L. E., *Soil Science*, 1935, 40, 311.
2. Twenhofel, W. H., *Principles of Sedimentation*, McGraw-Hill Book Company, New York, 1960, 434, 525.

#### NON-EJACULATED SPERMATOZOA IN THE EPIDIDYMIS OF *ANSER MELANOTUS* (AVES, ANSERES)

THE fate of non-ejaculated spermatozoa in the epididymis of birds has not been studied before though observations of this nature have been made in the different mammals.<sup>6-8</sup> It is known that there is no influence in the epididymis which can indefinitely preserve the vitality of mature spermatozoa, which become incapable of functioning after a certain period of ageing.<sup>1</sup>

The present paper gives an account of the various processes of elimination of undischarged spermatozoa left in the epididymis of *Anser melanotus* in the months of April and May after the breeding period is over. The epididymis with a portion of the testis was

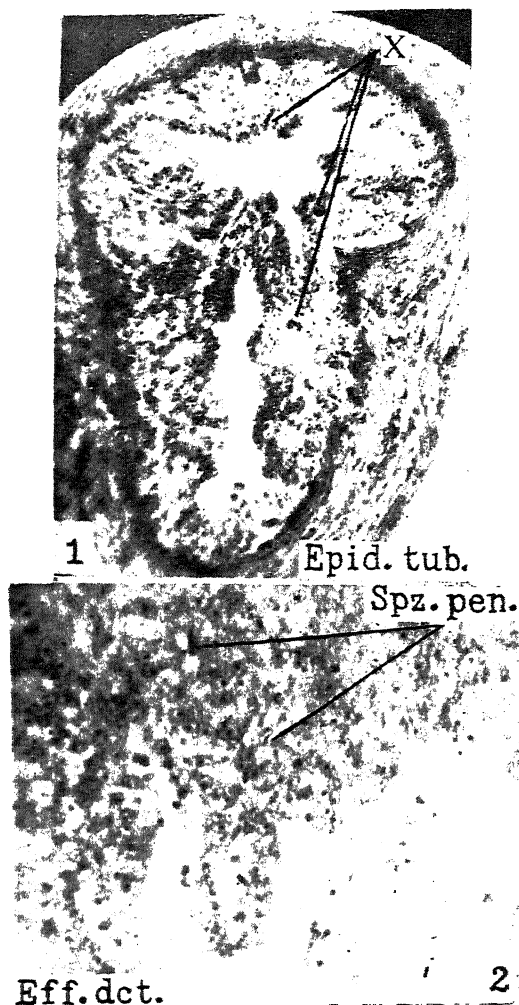
dissected out from the adult birds and fixed in warm Bouin's, Zenker's or Mann's fluid. A detailed study of the sections shows that in *Anser melanotos*, some of the spermatozoa left over in the epididymis after the breeding season undergo liquefaction—the end products of lique-

surrounding connective tissue and ultimately degenerate there.

The liquefaction and resorption of the spermatozoa in the seminal vesicle have been described.<sup>2-4</sup> Marshall<sup>5</sup> has suggested that such a resorption may take place by the cells of vasa efferentia or the testis itself in addition to the epithelium of the seminal vesicles. It is interesting to note that in birds, the liquefaction and resorption of spermatozoa takes place in the efferent ducts and epididymal tubules also. Spermiophagie, i.e., the process of destruction of spermatozoa by phagocytosis or engulfment by certain large cellular elements known as spermiophages has been described by many who believe that the spermiophages are the macrophage elements desquamated from the epithelium of the epididymal tubules. Lehner<sup>6</sup> believes them to be derivatives of the cells of sertoli.

My thanks are due to Dr. K. C. Bose for valuable suggestions and facilities of work.

Univ. Dept. of Zoology, P. N. MEHROTRA,  
Ranchi University,  
60, Circular Road, Ranchi, December 6, 1962.



FIGS. 1-2. Fig. 1. Photomicrograph of transverse section of the epididymis in April, showing non-ejaculated spermatozoa having penetrated into the wall of the epididymal tubule at X.  $\times 500$ . Fig. 2. Photomicrograph of a transverse section of the epididymis in April, showing non-ejaculated spermatozoa having penetrated into the wall of an efferent duct at X,  $\times 500$ .

faction being resorbed by the lining epithelial cells. A good number of them also find their way into the epithelial lining of the efferent ducts and epididymal tubules or even into the

1. Gray, J., *Journ. exp. Biol.*, 1931, **8**, 202.
2. Exner, S., *Handbuch der Urologie herausgegeben von Frisch*, 1904, **1**, 208.
3. Königstein, H., *Weiner klin. Woch.*, 1908, **21**, 971.
4. Simeone, F. A. and Young, W. C., *Journ. exp. Biol.*, 1931, **8**, 163.
5. Marshall, F. H. A., *Physiology of Reproduction*, Longmans, Green & Co., London, 1922, p. 170.
6. Lehner, J., *Zeitschr. f. mikrosk. anat. Forsch.*, 1924, **1**, 316.
7. Nemiloff, A., *Zeitscher f. Anat. u. Ent. geschichte*, 1926, **79**, 1.
8. Nakano, O., *Folia Anat. Japan*, 1928, **6**, 777.

#### REMARKS ON THE NOTE "SENSORY CANALS OF THE HEAD OF FEW CYPRINIDS"

IN his recent note on the cephalic sensory canals of three cyprinid fishes, Khandelwal<sup>1</sup> concludes that "the course of the sensory canals in cyprinids shows much similarity with a number of siluroids except for an addition of supra-cross-commissural canal and certain other differences in the details" and adds that this conclusion is at variance with that of mine published earlier.<sup>2</sup> I believe the following points would put the issue in the right perspective.

Barring few exceptions, the course of the cephalic sensory canals in the teleosts usually follows a definite pattern which could be reduced to a fundamental or what might be called the basic teleostean plan. Deviations



from such a plan occur in various groups of these fishes along more or less definite lines. Notwithstanding these deviations, however, the general arrangement of the sensory canals in them, by and large, still conforms to the original plan. When, therefore, comparisons are intended to be made among these groups of fishes (the cyprinids and the siluroids in the present context), these deviations from the basic plan are naturally taken into account. It is my considered opinion that a lack of regard for this fact highlights Khandelwal's interpretations.<sup>1</sup>

While I have investigated the sensory canal system of certain siluroids in the past,<sup>2-4</sup> I have had no opportunity to study the cyprinids in this respect so far. The comparisons drawn between these two groups of fishes in my earlier publication<sup>2</sup> have, therefore, been largely based on the opinions voiced by Allis<sup>5</sup> and Lekander<sup>6</sup>—opinions which, I believe, were the result of a thorough examination of a large number of cyprinid genera. Khandelwal<sup>1</sup> seems to have completely overlooked the work of Allis<sup>5</sup> and perhaps a hasty perusal of Lekander's account<sup>6</sup> has led him to a serious misunderstanding. The statement of Lekander<sup>6</sup> (p. 59) that "as a rule, the preopercular canal opens in the temporal canal" actually relates to the siluroids and not to the cyprinids, as attributed by Khandelwal.<sup>1</sup> Since Khandelwal<sup>1</sup> derives evidence from this misunderstanding to formulate his conclusions, their validity naturally remains open to question.

As for the cyprinids, Lekander<sup>6</sup> (pp. 104, 113, 122) explicitly states that in all the species examined by him the preopercular canal does not join the temporal canal, the supra- and infraorbital canals do not meet behind the eye, the supraorbital canal is continued caudally up to the parietal, and a supratemporal cross-commissural canal is present. Needless to say that in all the above respects the cyprinids studied by him stand in sharp contrast with the siluroids in general.

The observations of Khandelwal<sup>1</sup> on the three cyprinid fishes show that the sensory canals in them are better developed than of those studied by Lekander<sup>6</sup> and approach the conditions described for them in *Carrasius auratus* by Allis<sup>5</sup> (p. 437). The central point, however, is that in order to draw a comparison between the sensory canal systems of the cyprinids and the siluroids it becomes imperative to take into account all the available data on the subject, and when this is done, one finds it difficult to resist the conclusion that the canal system in the cyprinids as a whole shows positive signs of being involved in a process of reduction as

contrasted with the siluroids. This is what had precisely been stated in my earlier publication.<sup>2</sup>

The erroneous expression "supra-cross-commissural canal" has frequently been used by Khandelwal<sup>1</sup> for the term supratemporal cross-commissural canal. A supratemporal cross-commissural canal is invariably present in the cyprinids but is absent in the siluroids. The only record of this canal in the siluroids is that of Wright<sup>7</sup> and Collinge<sup>8</sup> on *Ameiurus catus*. However, Herrick<sup>9</sup> has denied its presence in this species and he and Allis<sup>5</sup> both failed to observe it in *Ameiurus nebulosus* as well.

Department of Zoology,  
University of Rajasthan,  
Jaipur (India), April 13, 1963.

A. S. KAPOOR.

1. Khandelwal, O. P., *Curr. Sci.*, 1963, **32** (3), 126.
2. Kapoor, A. S., *Trans. Amer. Micr. Soc.*, 1961, **80**, 329.
3. —, *Zeits. f. wiss. Zool.*, 1960, **164**, 315.
4. —, *Copeia*, 1961, No. 2, 176.
5. Allis, E. P., *Int. Mschr. Anat. Physiol.*, 1904, **21**, 401.
6. Lekander, B., *Acta Zool.*, 1949, **30**, 1.
7. Wright, R. R., *Proc. Canad. Inst.*, 1884, **2**, 251.
8. Collinge, W. E., *Proc. zool. Soc. Lond.*, 1895, **2**, 274.
9. Herrick, C. J., *J. comp. Neurol.*, 1901, **11**, 177.

#### THE CHROMOSOME NUMBERS IN SOME OF THE GRASSES OF ANDHRA PRADESH, INDIA

THE author has made chromosome counts in some of the species of grasses belonging to the genera *Melanocenchris* Nees, *Oropetium* Trin., *Iseilema* Hack., and *Eragrostis* Beauv.

The material was collected from the vicinity of Hyderabad City. The anthers were fixed in 1 : 3 acetic alcohol at 11:00 a.m. The anthers of *Melanocenchris royleana* Nees, fixed at 3:00 p.m., gave higher percentage of P.M.C. at diakinesis. The smears were made in aceto-carmin and the chromosomes were counted at diakinesis stage. In *Oropetium thomæum* (Linn. F.) Trin., the chromosome count was made at the late anaphase I.

At least twenty counts were made in each case.

The following are the new chromosome counts made during the present investigation :

1. *Melanocenchris royleana* Nees,  $n = 12$  (Fig. 1).
2. *Oropetium thomæum* (Linn. F.) Trin.,  $n = 5$  (Fig. 2).
3. *Eragrostis tenella* (Linn.) P. Beauv., ex Roem et Schult.  $n = 10$  (Fig. 3).

The following chromosome counts differed from the previous reports:

1. *Iseilema laxum* Hack.,  $n = 12$  (Fig. 4).
2. *Eragrostis poaeoides* P. Beauv.,  $n = 20$  (Fig. 5).

As far as the author is aware no species of the genera *Melanocenchris* Nees, and *Oropetium* Trin. has been worked out for its chromosome number up to this time. In the present investigation *Oropetium thomceum* (Linn. F.) Trin. gave  $n = 5$ . The author suggests 5 as the basic chromosome number for this genus. *Melanocenchris royleana* Nees has 12 as the gametic chromosome number, but with the present data it is difficult to suggest the basic chromosome number for this genus.



FIGS. 1-5. Pollen mother cells. Fig. 1. *Melanocenchris royleana* diakinesis,  $n = 12$ . Fig. 2. *Oropetium thomceum*, Late anaphase I,  $n = 5$ . Fig. 3. *Eragrostis tenella*, diakinesis,  $n = 10$ . Fig. 4. *Iseilema laxum* diakinesis,  $n = 12$ . Fig. 5. *Eragrostis poaeoides*  $n = 20$ .

*Eragrostis tenella* P. Beauv., ex Roem et Schult., with  $n = 10$  agrees with the basic chromosome number of the genus *Eragrostis* P. Beauv. ( $n = 10$ ), and it is a diploid species.

The chromosome count of *Eragrostis poaeoides* P. Beauv., with  $n = 20$ , fits in with the basic chromosome number of the genus *Eragrostis* P. Beauv., and it is a tetraploid species. However, Mulay and Jagdisan (1956) reported  $2n = 30$  for the same species from Rajasthan. Most probably they were working with a triploid

race, which must be highly sterile and relatively less viable and abnormal (Darlington, C.D., 1937; Darlington and Mather, K., 1951; Stebbins, 1951; Swanson, C. P., 1950).

The chromosome counts of *Iseilema laxum* Hack. were previously reported as  $2n = 36$  (Ramanathan, 1950),  $n = 4$  (Celarier et al., 1954) and  $n = 14$  (Joshi et al., 1959; Ramana Rao, T. N. V., 1962), but the author has observed  $n = 12$  in the material of the same species under present investigation.

The author wishes to express his grateful thanks to Prof. N. V. Subba Rao, Principal, for his kind encouragement, to Prof. M. R. Suxena for the facilities provided and for identifying the grasses, and to Dr. M. Hashim and Dr. Jafar Nizam for their useful suggestions.

University College of Science, U. B. S. SWAMI.  
Osmania University,  
Hyderabad-7 (A.P.), December 20, 1962.

1. Celarier, R. P. and Paliwal, R. I., *Science*, 1954, **126**, 1246.
2. Darlington, C. D., *Recent Advances in Cytology*, London, 1937.
3. — and Mather, K., *The Elements of Genetics*, London, 1950.
4. —, and Wylie, A. P., *Chromosome Atlas of Flowering Plants*, London, 1955.
5. Joshi, A. R., Patil, B. D. and Manchanda, P. I., *Curr. Sci.*, 1959, **28** (11), 454.
6. Mulay, B. N. and Jagdisan, *Proceedings, 43rd Session of Indian Science Congress, Agra, Part III, Abstracts*, 1956.
7. Ramana Rao, T. N. V., *Curr. Sci.*, 1962, **31**(11), 476.
8. Ramanathan, K., *Ibid.*, 1950, **19**(5), 155.
9. Stebbins, G. L., *Variation and Evolution in Plants*, New York, 1951.
10. Swanson, C. P., *Cytology and Cytogenetics*, London, 1950.

#### CROTOLARIA SPECTABILIS ROTH.— A NEW GREEN MANURING CROP FOR NORTHERN INDIA

AMONG the different green manuring forage and fibre crops of India, *Crotolaria juncea* Linn. (Sunnhemp) occupies an important place. But its cultivation for seed in North Indian plains is handicapped because of poor seed-setting and late maturity.

In other countries of the world some related species of *C. juncea* have also been used as green manuring crop. One of these, *C. spectabilis* Roth. (seeds of a variety of which were made available from U.S.A.\*), has been under study at Potato Experimental and Trial Centre, Babugarh (U.P.), since 1960. This gave much better performance than *C. juncea* and its

plants attained a height of 1½ metres and more and possessed copious branching full of broad, long leaves (15 cm. or more). As compared to *C. juncea*, *C. spectabilis*, when cultivated for green manure, took less time for growth, and during the same period gave 1½ times more bulking than *C. juncea*. The crop flowered by the end of September. The much-branched racemes, having plentiful bright yellow flowers, were up to 3 cm. long. The nodulation in the two species (*C. spectabilis* and *C. juncea*) was almost similar and the rotting of the plants when ploughed for green manure in the field took the same period. However, the seeds of *C. spectabilis* matured by the middle of October whereas those of *C. juncea* matured only by the middle of December. A comparative study of the plant growth, flowering and seed-setting in the two species (Table I), clearly brings out that *C. spectabilis* is more suited as a green manuring crop for north-western regions. Again, its seed being smaller in size (about 30,000 seeds per pound) helps to reduce the seed rate per acre.

TABLE I

Species		Mean number of pods per raceme	Mean number of seeds per pod	Mean weight of 100 seeds g.
<i>C. juncea</i>	..	5.22	8.84	4.167
<i>C. spectabilis</i>	..	11.28	16.88	1.977

*C. spectabilis* originally belongs to the old world and has been found to occur in a wild state in a number of States of India, but no economic selections have been made from it so far. In U.S.A., *C. spectabilis* is naturalised in the tropical region of the Southern States and some early maturing selections from this have gained commercial importance. The strain now being introduced into India appears to be well suited to the conditions prevailing in the north-western plains. However, it is yet too early to say anything about its suitability as a forage crop, because some of the strains are reported to possess small concentrations of monocrotaline—a poisonous alkaloid.

The author is thankful to Dr. Pushkarnath, Director, for kindly affording facilities for the above study.

Central Potato Res. Inst., HARI KISHORE.  
Simla, October 1, 1962.

\* Seeds received through the courtesy of Prof. R. W. Fulton, Department of Plant Pathology, University of Wisconsin, Madison, U.S.A.

1. McKee Rondaw and Pieters, A. J., *United States Department of Agriculture Year-Book*, 1937, p. 999.
2. Sabinis, T. A., "*Crotalaria juncea* Linn.," *Wealth of India*, C.S.I.R., New Delhi, 1950, 2, 427.

### EPIDERMAL STUDIES ON SOME SPECIES OF THE GENUS *ERAGROSTIS* P. BEAUV.

THE importance of cuticular studies from the systematic point of view has been stressed by several workers (Aydulov,<sup>1</sup> Brown,<sup>2</sup> Metcalfe,<sup>3</sup> Prat,<sup>4</sup> Tateoka<sup>5</sup>).

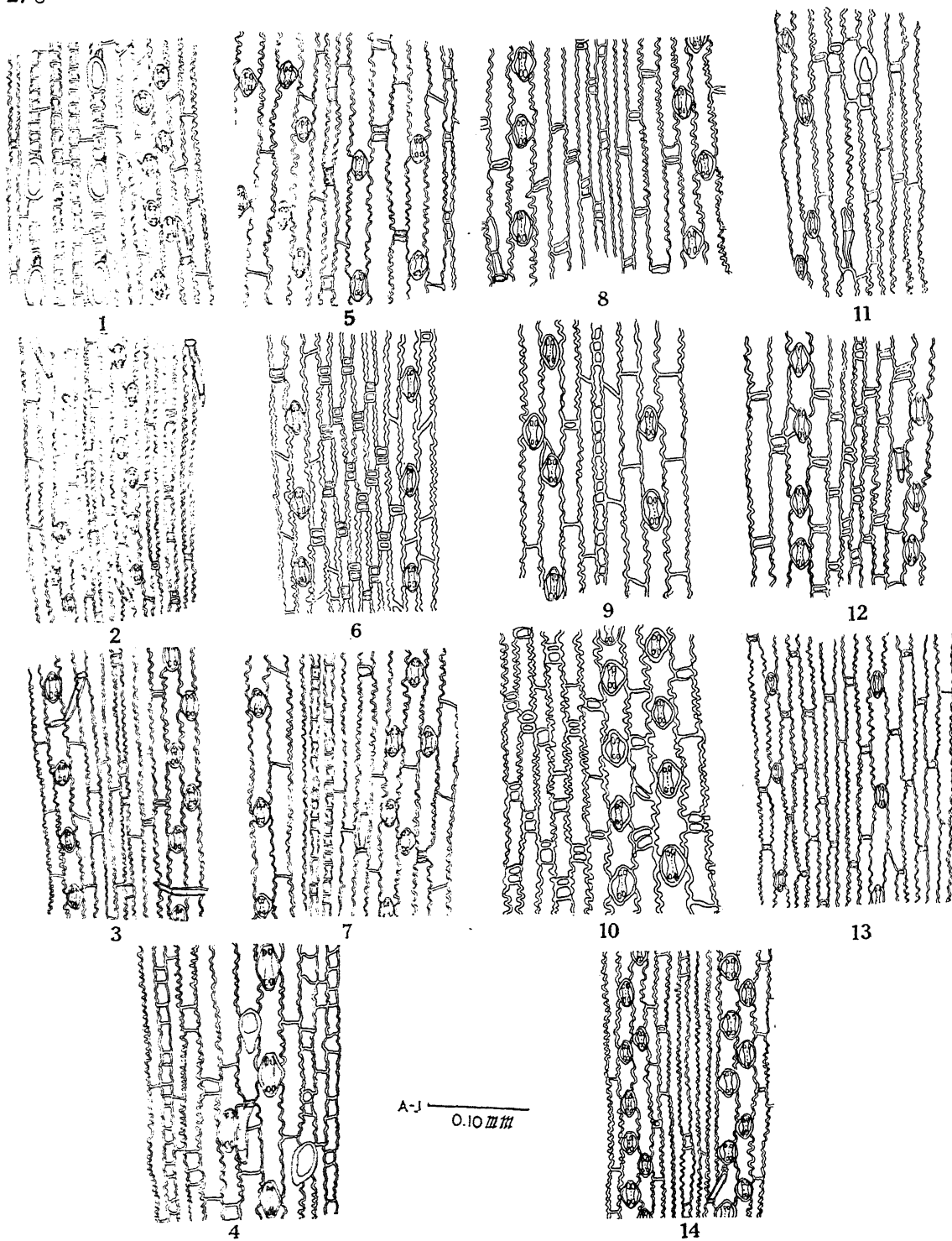
This genus belongs to the family Gramineæ, group Poideæ under tribe Eragrostæ (Bor<sup>6</sup>).

The slides were prepared by scrapping the epidermis and staining with aqueous safranin, mounting in glycerine and finally ringing with Canada Balsam. The herbarium material had to be first kept overnight in water, then for twenty-four hours in hydrofluoric acid (1% to 2%) to remove silica.

The terminology followed here is after Metcalfe.

Marked differences were found in the cellular make-up of species. The long cells are wavy in *E. pilosa*, *E. tenella*, *E. unioloides*, sinuations deep in *E. superba* rest with intermediate sinuations. In mostly all the species single short cells occur in coastal as well as in intercoastal regions, excepting in *E. superba* in which paired short cells occur in coastal as well as in intercoastal regions. The short cells are in rows in *E. cilianesis*, *E. curvula*, *E. diarrhena* and *E. pilosa*.

The silica bodies are mostly saddle-shaped but cross-shaped in *E. tenella* and *E. viscosa*. Tall and narrow silica bodies on coastal region occur in *E. cilianesis*, *E. nutans*, *E. pilosa*, *E. poaeoides* and *E. tenella*. In *E. cilianesis* and *E. poaeoides* this type occurs in intercoastal region also. The microhairs are absent in *E. diarrhena*, *E. megastachya*, *E. superba* and *E. unioloides*. The frequency is varying from species to species, e.g., 1 per mm.<sup>2</sup> in *E. cilianesis*, *E. curvula*, 1.4 in *E. nutans*, 3.66 in *E. tenella*, and 8 per mm.<sup>2</sup> in *E. viscosa*. The prickly hairs are present only in *E. cilianesis*, *E. curvula*, and *E. tenella*. The frequency of stomatal distribution and shape of the subsidiary cells was found to be varying. The frequency is maximum in *E. viscosa* with 205 per mm.<sup>2</sup>, then come *E. cilianesis*, *E. diarrhena*, *E. tenella* with 185, 186, and 175 per mm.<sup>2</sup> In *E. superba* and *E. unioloides* it is 144 and 154, finally *E. nutans* has 84 stomata per mm.<sup>2</sup> The subsidiary cells are mostly low dome-shaped, but conical in *E. curvula*,



FIGS. 1-14. Abaxial epidermis of some members of genus *Eragrostis*. Fig. 1. *E. ciliaris*. Fig. 2. *E. ciliaris*. Fig. 3. *E. ciliata*. Fig. 4. *E. curcula*. Fig. 5. *E. diarrhena*. Fig. 6. *E. megastochya*, Fig. 7. *E. poaeoides*. Fig. 8. *E. nutans*. Fig. 9. *E. pilosa*. Fig. 10. *E. superba*. Fig. 11. *E. tinella*. Fig. 12. *E. tremula*. Fig. 13. *E. unioloides*. Fig. 14. *E. viscosa*.

*E. nutans*, and low dome-shaped as well as conical in *E. cilianesis*, *E. unioloides* and *E. viscosa*.

Thus, cuticular studies can be as useful as morphological characters for identification and separation of one species from another.

I am thankful to Prof. K. N. Kaul for suggesting this problem and for his guidance and constant encouragement.

(Miss) KUM KUM ROY.

Nat. Bot. Gardens,  
Lucknow, February 18, 1963.

1. Avdulov, N. P., "Karyo-Systematische Unterchung der Familie Gramineen," *Bull. Appl. Bot. Genet. and Plant Breed.*, 1931, Suppl., 44, 1. (In Russian with 72 page German Summary).
2. Brown, W. V., *Bot. Gaz.*, 1958, 119, 170.
3. Metcalfe, C. R., *Kew Bull.*, 1954, p. 523.  
—, *Anatomy of the Monocotyledons*, Clarendon Press, Oxford, 1960.
4. Prat, H., *Ann. Sci. Nat. Bot. Ser.*, 1932, 14 (10), 117.
5. Tateoka, T., Sukemitsu, I., Kawano, S., *Bot. Gaz.*, 1959, 121, 79.
6. Bor, N. L., "The Grasses of India, Burma, Ceylon and Pakistan," *International Series of Monographs of Pure and Applied Biology*, Pergamon Press, Oxford, London, New York and Paris, 1960.

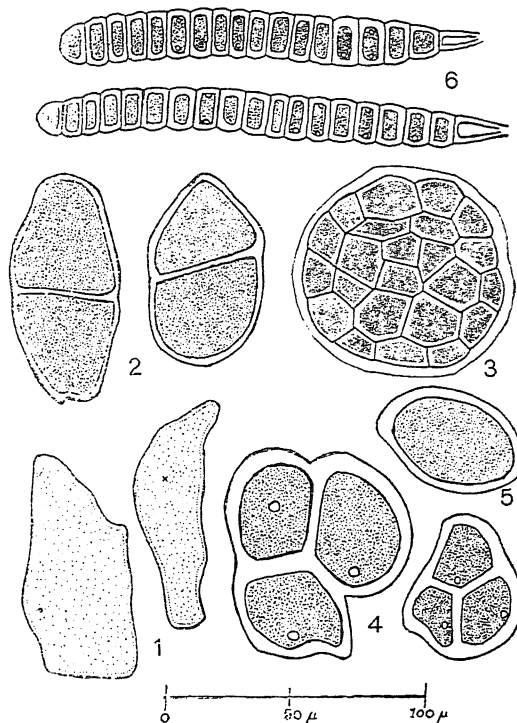
### SPORAE DISPERSAE OF THE RUST FUNGI (UREDINALES) FROM THE MIOCENE LIGNITE OF SOUTH INDIA

MACERATIONS of the lignite samples of Pilot Quarry and Bore Hole P.B. No. 5 of the Neyveli Lignite of the South Arcot District, Madras, have yielded myriad types of well-preserved spore forms and fruit bodies of fungi in addition to numerous types of pollen and spores of diverse angiospermic and pteridophytic elements respectively. The fruit bodies of fungi are comparable with those of *Microthyriacites*, *Notothyrites*, and *Plochmopeltinites* described by Cookson<sup>1</sup> from the Tertiary deposits of the Southern Hemisphere.

The present communication records for the first time from the Tertiary lignites of India, the occurrence of a distinctly preserved assemblage of significant sporomorphs showing morphological similarities with some of the extant members of the Rust Fungi (Cummins<sup>2</sup>). On account of the thick and heavily pigmented nature of the sporoderm, the sporomorphs of the urediospores and teliospores of the rust fungi represent the commonly preserved microfossils of the lignites. From the Eocene lignite of Palana (Rajasthan) Pareek<sup>3</sup> has recently recorded the occurrence of 2-celled and more than 2-celled forms of teliospores.

The following is the description of the sporomorphs of rust fungi recovered so far from the above lignite samples.

*Spore type 1* (Fig. 1).—Urediospores variously shaped, often roughly triangular, 12-30  $\times$  25-50  $\mu$ , wall colourless to pale yellow, 0.5 to 1  $\mu$  thick, sparsely echinulate, germ pores obscure. Spores of this type are abundantly preserved. These are comparable with the urediospores of *Milesia* White.



FIGS. 1-6

*Spore type 2* (Fig. 2).—Teliospores typically 2-celled by horizontal septum, 30-40  $\times$  18-20  $\mu$ , germ pore one in each cell, wall dark cinnamon brown to chestnut brown. The spore size and shape show a wide range. These spores are abundantly present and may be easily correlated with the teliospores of *Puccinia* Pers.

*Spore type 3* (Fig. 3).—Teliospores 1-celled, laterally united forming discoid heads of spores. Each cell shows the presence of one germ pore, wall chestnut brown. Pedicel or other structures like cysts not preserved. Spore heads about 55  $\mu$  in diam., consisting of 15-25 spores. These are commonly met with microfossils and are referable to the telial heads of *Ravenelia* Berk.

*Spore type 4* (Fig. 4).—Teliospores triquetrously 3-celled, germ pore one in each cell, wall

chestnut brown, spores  $20-45\mu$  in diam. The morphological features indicate that these are comparable with the teliospores of *Triphragmium* Link and *Haplophragmium* Syd. However, the presence of a single germ pore in each cell indicates a closer similarity with *Triphragmium*. Spores of this type seem to be fairly abundantly preserved in the South Arcot lignite.

**Spore type 5 (Fig. 5).**—Teliospores non-septate, 1-celled, borne singly on pedicels; with one germ pore, wall, cinnamon brown, spores  $29.5 \times 18.5\mu$ . These are very commonly preserved and show great variation in their size and shape. These resemble the teliospores of *Uromyces* (Link) Unger.

**Spore type 6 (Fig. 6).**—Teliospores borne singly on short pedicels, horizontally many times septate,  $105-125\mu$  long, apical cell  $7.8\mu$  broad, others about  $10.8\mu$  broad, pore one in apical cell and two in other cells, wall chestnut brown, very thick. These spores are quite common and referable to the teliospores of *Xenedochus* Schlect.

A comprehensive systematic study of the diverse sporomorphs of the rust fungi is in progress.

The authors are indebted to Dr. C. V. Ratnam, Dy. Superintendent of the Nyveli Lignite Corporation Ltd., for the kind supply of material.

Nizam College, C. G. K. RAMANUJAM.  
Saifabad College, P. RAMACHAR.  
Hyderabad (A.P.), November 26, 1962.

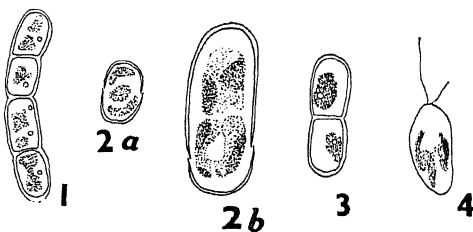
1. Cookson, I. C., *Proc. Linn. Soc. N.S.W.*, 1947, 72, 207.
2. Cummins, G. C., *Illustrated Genera of Rust Fungi*, 1959.
3. Pareek, H. S., *Rec. Geol. Surv. India*, 1962, 87, 823.

#### HETEROTHRIX ULOTRICHOIDES PASCHER IN INDIA

No MEMBER of the genus *Heterothrix* has so far been reported from India.<sup>1</sup> Only four genera of the class Xanthophyceae have been recorded as occurring in India. In the course of studies on freshwater algae of North India, a number of species, hitherto unrecorded, belonging to Xanthophyceae, have been collected. It is proposed to record and describe these algae individually.

Plants of *Heterothrix ulotrichoides* Pascher<sup>2,3</sup> have been collected repeatedly from small drying ponds in Lucknow, U.P., in the cold season. It flourishes as plankton, forming a pale-green

scum over the water. As the water gradually recedes from the fringe on account of progressive drying of the pond, the alga continues to thrive on the damp mud around. The filaments are uniseriate, unbranched and consist of uniform cylindrical cells, having slightly rounded ends (Fig. 1). The cell-wall is smooth, usually thin and composed of two equal or unequal slightly overlapping halves (Fig. 2a, b). However, this feature is not discernible in all cells. The cells measure  $8-9.6$  ( $\sim 10.8$ )  $\mu$  in breadth and  $12-16\mu$  in length. Each cell contains a few parietal chloroplasts but, uncommonly, only one chloroplast (Fig. 3) may be present. Oil globules are present as reserve food in the cells. There is a single nucleus in each cell.



FIGS. 1-4. *Heterothrix ulotrichoides* Pascher. Fig. 1. A short filament,  $\times 410$ . Fig. 2 (a & b). Cells showing the two overlapping halves of the cell wall, 2a  $\times 410$ ; 2b, 900. FIG. 3. Cells containing single chloroplast,  $\times 410$ . FIG. 4.  $\times 900$ .

Copious vegetative multiplication takes place by fragmentation and frequently one- or a few-celled bits of the filaments are found. Asexual reproduction takes place by means of zoospores (Fig. 4) which are formed singly in each cell and are liberated by the separation of the two halves of the cell-wall. The swimmers are sub-elliptical in shape and possess a short rod-shaped stigma in the anterior region. Two flagella of unequal length arise anteriorly and near their base two contractile vacuoles are present.

Sexual reproduction was not observed.

The authors wish to thank Prof. M. O. P. Iyengar for help in the identification of the alga.

Department of Botany, BRAJ NANDAN PRASAD.  
Lucknow University, P. N. SRIVASTAVA.  
Lucknow, U.P., November 23, 1962.

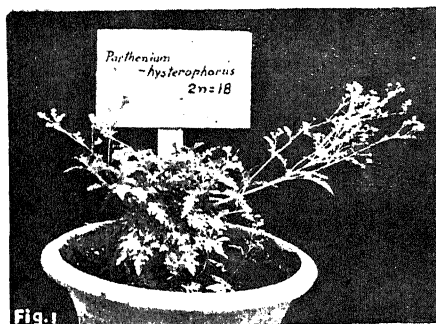
1. Biswas, K., *Rec. Bot. Surv. India*, 1949, 15, 1.
- \*2. Pascher, A., "Über einige neue oder kritische Heterokonten," *Arch. Prot.*, 1932, 77, 305.
3. —, *Heterokonten* in Rabenhorst's *Kryptogamen-Flora*, Akademische Verlagsgesellschaft M.B.H., 1939

\* Not seen in original.

# A DIPLOID *PARTHENIUM* IN JAMMU

THE genus *Parthenium* of which there are about 20 species belongs to the Western Hemisphere. Five species are found in Mexico of which *P. argentatum*, the Mexican rubber plant, rose to botanical prominence during the last war as a source of rubber. When examined cytologically Stebbins and Kodani (1944) found that it is a polymorphic species with chromosome numbers  $2n = 36, 54, 72$  with 0-2B chromosomes in the form with 36 chromosomes. These numbers in this species have been also reported by Catcheside (1950), who also found forms with  $2n = 108-111$ . Botschanzewa (1933) reported  $2n = 33$  in *P. incanum* in which species Stebbins and Kodani (1944) found plants with  $2n = 54$  and 72. The basic number for the genus was presumed to be  $x=9$  (Darlington, C. D. and Janaki Ammal, E. K., 1945).

The lowest chromosome number so far reported in the genus is the tetraploid  $2n = 36$ . A diploid species of *Parthenium* has now been discovered as a newly introduced weed in India. This is *P. hysterophorus* Linn. (Fig. 1) with  $2n = 18$  (Fig. 2) which found its way to Jammu from Poona together with some rooted cuttings of Jasmines. It is an annual having pinnately dissected alternate leaves with corymbose heads which have inconspicuously rayed florets.



FIGS. 1-2. Fig. 1. The plant of *Parthenium hysterophorus* Linn. Fig. 2 *P. hysterophorus*,  $2n=18$ ,  $\times 950$ .

My grateful thanks are due to Dr. I. C. Chopra, Deputy Director, Regional Research Laboratory, Jammu, for providing the Laboratory facilities.

Regional Research  
Laboratory,  
Jammu, May 16, 1963.

M. L. HAKOO.

3. Darlington, C. D. and Janaki Ammal, E. K., *Chromosome Atlas of Cultivated Plants*, George Allen and Unwin Ltd., London, 1945.
4. Stebbins, G. L. and Kodani, M., *J. Hered.*, 1944, 35, 163.

## A NOTE ON *EIMERIA* *RAJASTHANI* N. SP. (PROTOZOA : EIMERIIDAE) FROM THE INDIAN CAMEL (*CAMELUS* *DROMEDARIUS*)

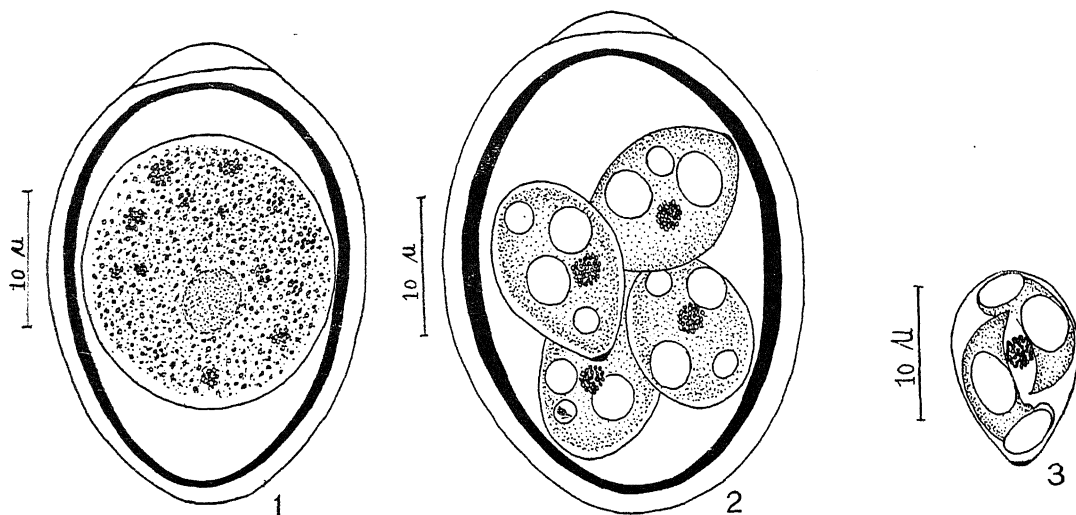
THE only report on coccidian oocysts from one-humped camel in Indo-Pakistan subcontinent is of Abdussalam and Rauf<sup>1</sup> who reported, from Lahore, the three species: *Eimeria* (*Globidium*) *cameli* Henry and Masson, 1932; *E. dromedarii* Yakimoff and Matschoulsky, 1939; and *E. nölleri* Reichenow, 1953. Records of eimerian infections, from abroad in *C. dromedarius* and *C. bactrianus*, are from France, Germany and Russia and the other species described are: *E. kasachstanica* Tzygankov,<sup>2</sup> 1950 and *E. pellerdyi* Prasad,<sup>3</sup> 1960.

During an examination of faecal samples collected from forty-five camel-calves of less than 10 months of age but with no clinical signs, twenty-eight samples contained coccidia with one species of *Eimeria*, described herein as a new species, *E. rajasthani*, occurring exclusively in eight and in the other twenty which also harboured another type, dealt with separately.

### *E. rajasthani*, N. SP.

This species was found in 28 camels. Hundred oocysts measured 34 to 39 by 25 to 27 microns with a mode of 36 by 25 microns, their length-width ratio varied from 1.30 to 1.44; shape nearly ellipsoidal; wall 2 to 3 microns thick, composed of two layers, the outer one thicker and light yellowish green, and inner one darker with a shining inner contour; micropyle not visible; micropylar end with a well-defined cap, 8 to 11 microns wide and 2 to 3 microns high; the sporont, nearly as wide as the oocyst with granular cytoplasm and a prominent nucleus, 17 to 20 microns in diameter (Fig. 1). Sporulation was completed in about a week. Sporocysts almost ovoid with a single-layered wall and a prominent thickening (stieda body) at its narrower end. Fifty sporocysts measured 14 to 15 by 8 to 11 microns, with a mode of 15 by 11 microns. Oocystic polar granule absent. Oocyst residuum absent sporocyst residuum present between the two sporozoites (Fig. 2). Sporozoites elongated, 10 to 14 microns by 3 to 4, with one end broad and the other narrower but pointed containing two or sometimes more prominent globules (Fig. 3).

1. Botschanzewa (*vide* Darlington and Janaki Ammal, Ref. 3).
2. Catcheside, D. G., *Genet. Iber.*, 1950, 2, 139.



FIGS. 1-3. Fig. 1. Showing an unsporulated oocyst. Fig. 2. a sporulated oocyst. Fig. 3. sporocyst, after rupture of an oocyst.

A perusal of the literature shows conflicting views held on the question of validity and synonymy of some of the species described from camels, viz., *E. cameli*, *E. nölleri* and *E. dromedarii*. In a revision of the coccidia fauna of camels, Tzygankov recognised only the two species; *E. cameli* Iwanoff-Gobzem, 1934 (= *E. dromedarii* Yakimoff and Matschoulsky, 1939) and *E. kazakhstanica*, n. sp., to which *E. pellerdyi* has to be added.

The oocysts of *E. rajasthanii* are distinct from *E. cameli* on account of their ellipsoidal shape and in the presence of a compact sporocystic residuum. They differ from those of *E. kazakhstanica* on account of the smaller size of both oocysts and sporocysts, their different shape and in the presence of stieda body. *E. pellerdyi* is distinguished from the proposed new species in the smaller size of its oocyst, absence of a polar cap and smaller size of the oocyst. Detailed work on this and other species from camels is in progress.

Thanks are due to Dr. Norman D. Levine for his suggestions; to the Indian Council of Agricultural Research, New Delhi, for the award of a Junior Research Fellowship to one of us (J. P. D.); to the Officer-in-Charge, Camel Breeding Farm, Bikaner (Rajasthan), for facilities provided and to Prof. S. N. Boev for loan of Russian paper.

Department of Parasitology,

U.P. College of Veterinary

Science and Animal Husbandry,

Mathura (U.P.), December 8, 1962.

J. P. DUBEY.

B. P. PANDE.

1. Abdussalam, M. and Rauf, A., *Proc. 9th Pakistan Sci. Conf. Peshawar*, 1957, Part III, 125.
2. Tzygankov, A. A., *Izvestia Akad. Nauk. Kazakh. SSR.*, 1950, 8, 174.
3. Prasad, H., *Z. F. Parasitkunde*, 1960, 20, 390.

#### THE CHROMOSOME NUMBER OF *URÆOTYPHLUS MENONI* ANNANDALE

THE Apodan genus, *Uræotyphlus*, has a very circumscribed distribution.<sup>1,2</sup> The species described<sup>1,3,4</sup> are from the Western Ghats region of the Malabar coast. Several specimens of *Uræotyphlus menoni* Annandale were collected from Koduvalli, a village about 13 miles north of Calicut, during the years 1960-63. The restricted distribution of the genus and the difficulty in collecting and keeping alive the specimens is perhaps responsible for our very scanty knowledge of the cytology of these forms. Only some aspects of the spermatogenesis of *U. narayani*<sup>5</sup> are known.

The availability of living *U. menoni* suggested an exploration with the hæmatoxylin squash technique<sup>6-8</sup> the chromosome number of this species. While a fair scattering of the chromosomes could be obtained in the spermatogonia, it was found difficult to separate by mere pressure the chromosomes in the liver cells of young specimens. This necessitated a pretreatment with a hypotonic salt solution.<sup>9</sup>

Clippings of the testis and liver were exposed to a 0.9% sodium citrate solution at room tem-



perature for 60 minutes and then fixed in acetic alcohol (1 : 3) at the same temperature for an hour. The vials containing the material in the fixative were then stored in a refrigerator at

5-8° C. for three days. With interspaced washes in distilled water, the tissues were hydrolysed in N HCl at 60° C. for 15 minutes, mordanted in 4% ferric ammonium sulphate for 60 minutes,



PHOTOS. 1-3. Photo. 1. Two spermatogonial metaphases lying side by side,  $\times ca. 1,500$ . Photo. 2. Metaphase plate from a liver cell,  $\times ca. 1,500$ . Photo. 3. Well scattered metaphase chromosomes of a liver cell,  $\times ca. 1,500$ . Photos. 3 A/ & 3 B. Enlargements of regions A and B of the metaphase plate illustrated in Photo 3,  $\times ca. 2,300$ .

stained with a 0.5% well-ripened solution of hæmatoxylin for 120 minutes, squashed in a drop of 45% acetic acid under a coverslip and then sealed with paraffin wax. The photographs are from such temporary mounts. The treatment with sodium citrate was found to lengthen and swell the chromosomes slightly.

Photo 1 illustrates two spermatogonial metaphases, each with 36 chromosomes. This number finds confirmation in the metaphase plates of dividing liver cells presented as Photos 2 and 3. While the chromosomes are stumpy in the spermatogonia (Photo 1) they are relatively longer and slender in the liver cells (Photo 2). They are spread well in Fig. 3. The enlargements, Photo 3 A and Photo 3 B, illustrate the morphology of the 36 chromosomes.

The most reliable character on which *U. menoni* could be separated from *U. narayani* is the length of the snout as compared with the inter-ocular distance. Since the validity of this character has been questioned by Parker<sup>2</sup> in another context and since they have an identical chromosome number,<sup>5-10</sup> only a critical analysis of the idiograms of these two species would elucidate whether there are differences in the morphology of the chromosomes.

N. BALAKRISHNAN ELAYIDOM.\*

SARASWATHY ROYAN-SUBRAMANIAM.\*\*

M. K. SUBRAMANIAM.

Cytogenetics Lab.,  
Dept. of Biochemistry,  
Indian Inst. of Science,  
Bangalore-12,  
May 24, 1963.

\* Lecturer in Zoology, Farook College, Feroke, Kerala State.

\*\* Scientists' Pool, C.S.I.R.

1. Boulenger, G. A., *The Fauna of British India: Reptiles and Batrachia*, Taylor and Francis, London, 1890, p. 515.
2. Parker, H. W., *Ann. Mag. Nat. Hist.*, 1927, **20** (118), 478.
3. Annandale, N., *Rev. Ind. Mus.*, 1913, **9**, 301.
4. Seshachar, B. R., *Proc. Ind. Acad. Sci.*, 1939, **9B**, 224.
5. —, *La Cellule*, 1939, **38**, 63.
6. Marimuthu, K. M. and Subramaniam, M. K., *Curr. Sci.*, 1960, **29**, 482.
7. Royan, S., *Proc. Ind. Acad. Sci.*, 1962, **55B**, 201.
8. Mangalangi, N. K. and Subramaniam, M. K., *Curr. Sci.* (In press).
9. Hsu, T. C., *J. Heredity*, 1952, **43**, 167.
10. Matthey, R., *Les Chromosomes des Vertébrés*, F., Rouge, Lausanne, 1949, p. 261, pl. VI.

# **CURVULARIA VERRUCIFORMIS** **AGARWAL AND SAHNI,** **A NEW FUNGUS FROM JABALPUR** **(M.P.)**

WHILE making isolations from foot-rot of wheat collected from several fields in Jabalpur, India, during November 1960, the authors encountered a *Curvularia* sp. which differed from all other known *Curvularias*. Its characteristics are as described below.

Conidiophores light brown, simple, sometimes branched, erect, straight or bent, septate, of variable length, up to  $4\mu$  broad towards the base and broader towards the apex, upto  $6.7\mu$ ; conidia in spirals, usually curved, sometimes straight, usually 4-septate, rarely 5-septate, third cell from the base disproportionately large and darker, sometimes all the central cells are concolorous, the end cells lighter coloured, rough epispore over the central cells, end cells with smooth epispore, basal cell with a scar indicating the point of attachment to the conidiophore,  $16.5-24.8 \times 7-11.6\mu$ ; average  $20.2 \times 9.2\mu$  (Fig. 1).

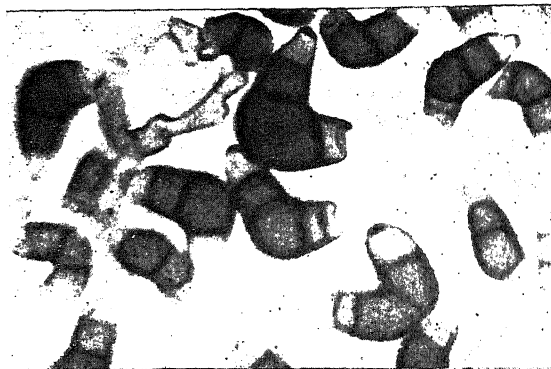


FIG. 1. *Curvularia verruciformis*—Photomicrograph showing conidia and conidiophores.

The conidia are usually 4-septate and therefore the fungus falls in the *geniculata* group. The rough epispore over the central cells in the present isolate is a very characteristic feature which has not been described before. The present isolate shows resemblance with *C. verruculosa* Tandon and Bilgrami<sup>1</sup> in the nature of verrucose epispore but is distinct from it in that the end cells have smooth epispore, the epispore of only the central cells is rough, it belongs to the *geniculata* group and not to the *lunata* group. It is therefore being described here as a new species.

*Curvularia verruciformis* AGARWAL AND  
SAHNI Sp. Nov.

Conidiophora pallide brunnea, simplicia, nonnumquam ramosa, erecta vel curvata, septata, longitudinis variæ, usque ad  $4\mu$  lata ad basin, latiora ad apicem usque ad  $6.7\mu$ ; conidia in spiris, brunnea, ex ellipsoideis fortiter curvata, vulgo 4-raro 5-septata, tertia cellula ex basi amplissima et fusciori, nonnumquam cellulis centralibus omnibus concoloribus, cellulis terminalibus pallidioribus, cellulis mediis episporio aspero opertis, terminalibus vero levi, cellula basali cicatrice ornata monstrante punctum unionis cum conidiophoro,  $16.5-25.8 \times 7-11.6\mu$ , mediet  $20.2 \times 9.2\mu$ .

Nova hæc species lecta est inficiens *Triticum* ad Jabalpur in India mense novembri 1960.

The type culture has been deposited in the Herbarium I.M.I. No. 92671.

We express our grateful thanks to Dr. M. B. Ellis and Dr. E. G. Simmons for kindly examining the cultures and to Rev. Fr. Prof. H. Santapau, Chief Botanist, Botanical Survey of India, for his kindness in rendering into Latin the diagnosis of the new species. Our thanks are also due to the Principal, Government Science College, Jabalpur, for the laboratory facilities.

Department of Botany, G. P. AGARWAL.  
Government Science College, V. P. SAHNI.  
Jabalpur, November 26, 1962.

1. Tandon, R. N. and Bilgrami, K. S., *Curr. Sci.*, 1962, **31**, 254.
2. Subramanian, C. V., *Proc. Ind. Acad. Sci.*, 1953, **38 B**, 27.

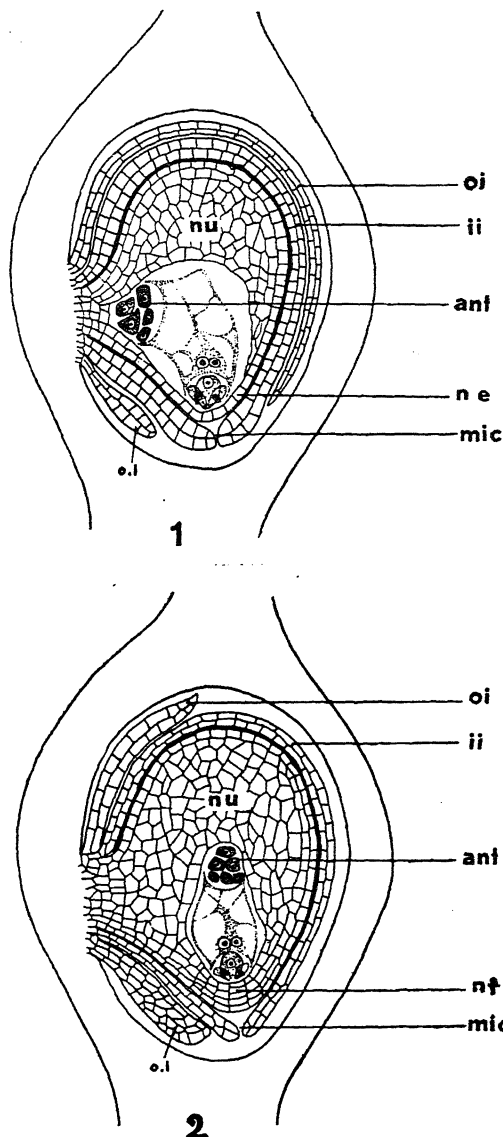
# SOME OVULE CHARACTERS IN THE SYSTEMATICS OF GRAMINEÆ

In several recent papers newer criteria have been used in delimiting the two subfamilies and various tribes of the Gramineæ. Avdulov<sup>1</sup> first emphasized the importance of cytological characters in the systematics of grasses while Prat<sup>2,3</sup> took advantage of epidermal and anatomical characters of the leaf. More recently the roles of starch-grains of the seeds,<sup>4</sup> of persistent nucleoli,<sup>5</sup> of the root-hair development,<sup>6</sup> of the organization of shoot apex,<sup>7</sup> and of the various embryo characters<sup>8</sup> have been emphasized.

However, during the course of an investigation on the embryology and fruit development of a few locally occurring wild grasses<sup>9</sup> certain interesting features of the ovule have been noted by the author. These seem to differ markedly in the two subfamilies and are tabulated here for the species worked out.

The first point of difference relates to the

extent of development of the outer integument. As is well known, the ovule in the Gramineæ is anatropous or semi-anatropous and bitegmic and the micropyle is formed by the inner integument which completely invests the nucellus. In the Pooideæ the outer integument also is quite well developed and invests the ovule for the greater part except for the micropylar region (Fig. 1). In the Panicoideæ, on the



FIGS. 1-2. Fig. 1. Diagrammatic representation of a longitudinal section of the ovule in the sub-family Pooideæ. Fig. 2. Diagrammatic representation of a longitudinal section of the ovule in the sub-family Panicoideæ. *an*, antipodals. *ii*, inner integument. *mic*, micropyle. *ne*, nucellar epidermis. *nt*, nucellar tissue. *nu*, nucellus. *oi*, outer integument

TABLE I

Species		Outer Integument Long (L) or Short (S)	Nucellar tissue Present (P) or Absent (A)	Antipodals lateral (l) or chalazal (c)
<i>Subfamily: Pooideae</i>				
Tribe: Festuceae				
<i>Poa annua</i>	(Present author)	L	A	l
<i>Poa pratensis</i>	(Andersen, 1927) <sup>11</sup>	L	A	l
<i>Poa compressa</i>		L	A	l
Tribe: Hordeae				
<i>Triticum vulgare</i>	(Percival, 1921) <sup>12</sup>	L	..	l
Tribe: Eragrostae				
<i>Dactyloctenium aegyptium</i>	(Present author)	L	A	l
<i>Eragrostis coarctata</i>		L	A	l
<i>Eragrostis poaeoides</i>		L	A	l
<i>Eragrostis unioloides</i>		L	A	l
<i>Eleusine indica</i>		L	A	l
<i>Eleusine coracana</i>	(Narayanaswami, 1955) <sup>13</sup>	L	A	l
Tribe: Chlorideae				
<i>Cynodon dactylon</i>	(Present author)	L	A	l
<i>Chloris infata</i>		L	A	l
Tribe: Zoiseae				
<i>Tragus biflorus</i>	(Present author)	L	A	l
<i>Sub-family: Panicoideae</i>				
Tribe: Paniceae				
<i>Panicum miliaceum</i>	(Narayanaswami, 1955) <sup>14</sup>	S	P	c
<i>Panicum miliare</i>		S	P	c
<i>Echinochloa frumentacea</i>	(Narayanaswami, 1955) <sup>15</sup>	S	P	c
<i>Pennisetum typhloideum</i>	(Narayanaswami, 1953) <sup>16</sup>	S	P	c
<i>Paspalum scribiculatum</i>	(Narayanaswami, 1954) <sup>17</sup>	S	P	c
<i>Setaria italica</i>	(Narayanaswami, 1956) <sup>18</sup>	S	P	c
<i>Brachiaria ramosa</i>	(Present author)	S	P	c
Tribe: Andropogoneae				
<i>Aplusia mutica</i>	(Present author)	S	P	c
Tribe: Maydeae				
<i>Zea mays</i>	(Randolph, 1936) <sup>19</sup>	S	P	c

other hand, the outer integument extends only up to about half the length of the ovule (Fig. 2). It may or may not be produced into a process towards the roof of the ovary cavity.

Secondly, in the Pooideae, the nucellar epidermis below the micropyle does not usually divide periclinally (Fig. 1) while in the Panicoideae it divides to form a very well-developed nucellar tissue that takes up the appearance of parietal tissue (Fig. 2).

Another point pertains to the position occupied by the antipodals during the various stages of development of the ovule. In the Pooideae they come to occupy a lateral position in the embryo-sac prior to their degeneration (Fig. 1), while in the Panicoideae they continue to occupy a chalazal position in the embryo-sac until the time of their degeneration (Fig. 2). Shadovsky<sup>10</sup> has given a list of grasses with chalazal and lateral antipodals. From his table also it appears that a majority of grasses belonging to the Pooideae possess lateral antipodals, while those of the Panicoideae have chalazal antipodals, with a few exceptions.

From Table I it is clear that the three points enumerated above are quite valid

for the species for which these characters are known. Most of the authors studying embryology of different grasses, however, did not give much importance to such characters. It may be worthwhile to determine them in all the other grasses.

Grateful thanks are due to Professor V. Puri for guidance and Dr. Y. S. Murty for helpful suggestions. Thanks are also due to the authorities of C.S.I.R., New Delhi, for financial assistance.

School of Plant Morphology, NARESH CHANDRA.  
Meerut College,  
Meerut (India), December 5, 1962.

1. Avdulov, N. P., *Bull. Appl. Bot. Suppl.*, 1931, **44**, 428.
2. Prat, H., *Ann. Sci. Nat. Ser. Bot. X*, 1936, **18**, 165.
3. —, *Proc. International Bot. Congress*, Montreal, 1959, **2**, 308.
4. Tateoka, T., *Jour. Jap. Bot.*, 1954, **29**, 341.
5. Brown, W. V. and Emery, W. H. P., *Am. Jour. Bot.* 1957, **44**, 585.
6. Clark Row, H. and Reeder, J. R., *Ibid.*, 1957, **44**, 596.
7. Brown, W. V., Heimsch, C. and Emery, W. H. P., *Ibid.*, 1957, **44**, 590.

8. Reeder, J. R., *Am. Jour. Bot.*, 1957, **44**, 756.
9. Chandra, N., *Ph.D. Thesis*, Agra University, 1960.
10. Shadowsky, A. E., *Flora*, 1926, **120**, 344.
11. Andersen, A. M., *Jour. Agr. Res.*, 1927, **34**, 1001.
12. Percival, J., *The Wheat Plant—A Monograph*, London, 1921.
13. Narayanaswami, S., *Michigan Acad. Sci. Arts and Letters*, 1955, **40**, 33.
14. —, *Lloydia*, 1955, **18**, 61.
15. —, *Phytomorphology*, 1955, **5**, 161.
16. —, *Ibid* 1955, **3**, 98.
17. —, *Bull. Torr. Bot. Club*, 1954, **81**, 288.
18. —, *Bot. Gaz.*, 1956, **118**, 112.
19. Randolph, L. F., *Jour. Agr. Res.*, 1936, **53**, 881.

### A NEW SPECIES OF PHOMOPSIS FROM JABALPUR

IN the course of the study of fungus flora of Jabalpur the author encountered a leaf spot on *Teramnus labiales* Spreng. The disease first appears as small ash-coloured spots, usually starting from the apex or margin of the leaf-blade. Mature spots are ash-coloured in the central region with a light brown halo. Pycnidia appears as small black dots in the central region. At later stages spots increase in size and cover 3/4th of the leaf-blade. Midrib and the chief veins are freely traversed.

The examination of the lesions revealed the pathogen to be *Phomopsis*.

Pycnidia dark brown, globose to subglobose, superficial, 60–155  $\mu$  in diameter; conidiophores small, hyaline; conidia hyaline, single celled, oval to fusoid, 6.6–11.6  $\times$  5–9.2  $\mu$ .

The present fungus is similar to *Phomopsis pterocarpi* Hughes described by Hughes<sup>1</sup> (1953) on leaves of *Pterocarpus erinacei* from Gold Coast. *P. pterocarpi* measures 6.9  $\times$  2.5–3  $\mu$  and thus the present fungus differs in having larger and broader conidia. It is, therefore, being described here as a new species *Phomopsis teraminæ*.

*Phomopsis teraminæ* HASIJA SP. NOV.

Pycnidia brunnea, globosa vel subglobosa, superficiales, diametentia 60–155  $\mu$ ; conidiophori minutissimi, hyalini; conidia hyalina, semel cellulata, ovalia vel fusoideæ, 6.6–11.6  $\times$  5–9.2  $\mu$ .

Habit in foliis vivis *Teraminæ labialae* ad Jabalpur in India, mense Septembri anni 1961, leg—Hasija.

The material was examined by Mr. Sutton of C.M.I., Kew. The type specimen has been deposited in the I.M.I. Herb. No. 89440.

The author expresses his grateful thanks to Dr. G. P. Agarwal for guidance, and to Dr. J. C. F. Hopkins, Director, C.M.I., Kew, England, for help in identification.

Department of Botany,  
Government Science College,  
Jabalpur, November 30, 1962.

S. K. HASIJA.

1. Hughes, S. J., "Fungi from Gold Coast-II," *Mycol. Pap. C.M.I.*, 1953, **50**, 54.

### OCCURRENCE AND DISTRIBUTION OF SOME UNCOMMON AMINO-ACIDS IN TAMARIND SEEDLING

DONE AND FOWDEN<sup>1</sup> had first discovered the presence of  $\gamma$ -methylene glutamic acid and  $\gamma$ -methylene glutamine, a new and third amide to occur in plants, in free state in *Arachis hypogea* seedlings and since then its presence has been reported from a specific group of plants belonging to the family Liliaceæ.<sup>2-4</sup> Because of its rather restricted distribution phylogenetic significance has been assigned to its occurrence. Many other uncommon amino-acids have been shown to occur in various other plants<sup>5-6</sup> but not in one single plant have so many of the uncommon amino-acids been reported as are found in young tamarind seedlings.

Two-dimensional chromatography of 70% ethanol extract obtained from different seedling parts of the five and ten days old tamarind seedlings, grown in light and dark, showed the presence of large amounts of  $\gamma$ -methylene glutamine and still greater amounts of  $\gamma$ -methylene glutamic acid along with many other hitherto unknown spots. Figure 1 gives

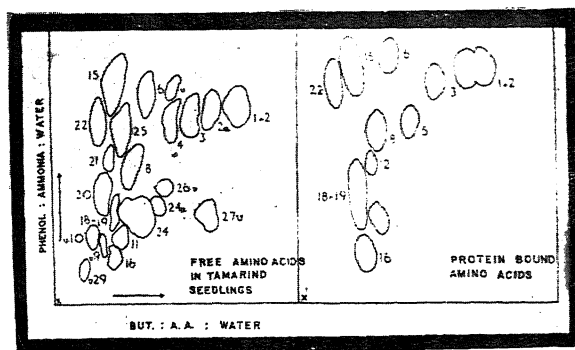


FIG. 1. showing the positions of various free and protein bound amino acids and amides present in tamarind seedlings in two-dimensional trace chromatograms. 1 & 2, Leucine and Isoleucine; 2a, Phenylalanine; 3, Valine; 4, Aminobutyric acid; 5, Tyrosine; 6, Proline; 8,  $\alpha$ -Alanine; 11, Glutamic acid; 12, Threonine; 15, Arginine; 18 & 19, Glycine and Serine; 20, Asparagine; 21, Glutamine; 22, Histidine and Lysine; 24, Methylene glutamic acid; 24a, Methyl glutamic acid; 25, Methylene glutamine; U, Unidentified amino-acids.

a pattern of the two-dimensional chromatogram locating the positions of various amino acids and amides in tamarind seedling. The various identifications have been made by comparison with the standard Rf values obtained with the solvent system using pure reference compounds obtained by the courtesy of Dr. L. Fowden, and by co-chromatographing.

Table I shows the Rf values obtained for the different uncommon amino-acids, the unknowns, and their distribution in various parts of the seedling.

TABLE I

Table showing the Rf values and the colour reactions of various amino-acids and amide of uncommon occurrence in the five days old tamarind seedlings. Solvents used were Phenol: Ammonia: Water in the first direction and Butanol: Acetic-acid: Water (4: 1: 5) in the other direction

Amino-acids	Rf. related to $\alpha$ -alanine	Ninhydrin colour reactions	Root	Hypocotyl	Cotyledon	Plumule
$\gamma$ -Methylene glutamic acid ( $\gamma$ -MGA)	0.67/1.0	Yellow brown	***	***	*	***
$\gamma$ -Methylene glutamine ( $\gamma$ -MG)	1.19/0.82	Yellow brown	**	**	*	**
$\gamma$ -Methyl glutamic acid	0.77/1.39	Purple	*	*	..	*
Unidentified-27	0.67/1.98	Brownish yellow	*	*	*	*
" - 9	0.45/0.64	Purple	*	*	*	..
" -10	0.49/0.45	Purple	*	*	..	..
" -26	0.85/1.3	Purple	*	*	..	**
" -29	0.27/0.50	Purple	*	*	..	..

Number of stars shows the relative quantities present while — is for absence.

Analysis of protein amino-acids obtained after acid hydrolysis with 6N HCl at 15 lb. pressure for 30 minutes gave no indications of the presence of any of these acids in the protein.

Although, as earlier reported,  $\gamma$ -methylene glutamic acid and  $\gamma$ -methylene glutamine, along with other unidentified acids, are not constituents of protein, and are formed only secondarily by the breakdown of the protein, the behaviour of  $\gamma$ -MGA and  $\gamma$ -MG is different from that of *Arachis hypogea* or the plants belonging to family Liliaceae in that the acid always dominated over the corresponding amide in various parts of the tamarind seedling grown in both light and dark and at no stage of the seedling growth up to ten days was  $\gamma$ -MGA found in amounts lower than  $\gamma$ -MG.

Detailed work will be reported elsewhere.

The authors are grateful to Dr. L. Fowden of the University College, London, for the gift samples of  $\gamma$ -MGA,  $\gamma$ -MG,  $\gamma$ -methyl glutamic acid and  $\gamma$ -hydroxy glutamic acid. Our thanks are also due to Prof. Shri Ranjan for advice and to Prof. R. N. Tandon, for providing the

necessary laboratory facilities. One of us (K. K. P.) thanks the C.S.I.R. for financial assistance.

Dept. of Botany, (Miss) K. K. PATNAIK.  
Univ. of Allahabad, M. M. LALORAYA.  
December 19, 1962.

1. Done, J. and Fowden, L., *Biochem. J.*, 1952, **51**, 451.
2. Zachariou, R. M., Pollard, J. K. and Steward, F. C., *J. Amer. Chem. Soc.*, 1954, **76**, 1961.
3. Wickson, M. E. and Towers, G. H. N., *Canad. J. Biochem. Physiol.*, 1956, **34**, 502.

4. Fowden, L. and Steward, F. C., *Annals Bot. (London)*, 1957, **21**, 53.
5. Steward, F. C. and Pollard, J. K., *Ann. Rev. Plant Physiol.* 1957, **8**, 65.
6. Thompson, J. F., *et al.*, *Bot. Rev.*, 1959, **1**, 25.

## EPIDERMAL STRUCTURE OF PINNAE OF *MACROZAMIA* MIQ.

CUTICULAR AND EPIDERMAL studies of ten species of *Macrozamia*, viz., *M. cylindrica* Moore, *M. communis* L. Johnson, *M. fawcettii* Moore, *M. hopei* Hill, *M. macleayi* Miq., *M. moorci* Muell, *M. pauli-guilmii* Hill et Muell, *M. peroffskyana* (Regel) Miquel, *M. reidlei* (Gaud.) C. A. Gardner and *M. secunda* Moore have been made. The epidermal cells are arranged either in rows running obliquely to the veins as in *M. peroffskyana*, *M. hopei* and *M. macleayi* or in rows which are parallel to the veins as is seen in the remaining species investigated by us. The anticlinal walls of epidermal cells are sinuous in *M. cylindrica*, *M. communis*, *M. moorei* and *M. reidlei*. In *M. cylindrica* and *M. communis* the anticlinal

walls are deeply undulate near the line of their junction with the outer periclinal walls and relatively less sinuous along their edge which joins the inner periclinal wall. The convex bends of the sinuous anticlinal walls show oval or rounded pits on the concave side of each bend. The anticlinal walls of epidermal cells in the six species are almost straight or arched. Two types of epidermal cells are invariably present in the pinnæ of all the species of the genus. Some of them are thick-walled while others are thin walled. Other interesting features of the various species of the genus include the occurrence of papillate outgrowths at or near the end walls of the epidermal cells in the pinnæ of *M. pauli-guilelmii* and *M. secunda* (see Fig. 2) and the occurrence of short

striations like those of *Stangeria paradoxa*, *Bowenia spectabilis*<sup>1</sup> or *C. revoluta*.<sup>2</sup> The lateral walls of the guard cells in *M. communis*, *M. fawcettii* and *M. pauli-guilelmii* show small spine-like outgrowths (see Fig. 1). The hypodermal cells of *M. reidleyi* show dark bands which run parallel to the leaf surface. The palisade and spongy mesophyll cells of this species show anastomosing thickened bands which form a reticulate pattern. Such thickened cells are unknown in the mesophyll of any other cycad, although the palisade cells of the leaflets of *Cycas* are reported to have some kind of thickenings.<sup>3</sup> The taxonomic value of the above-mentioned characters is obvious but their ultimate utility in the determination of different species of the genus can be



FIGS. 1-2. Fig. 1. *Macrozamia communis*. A stoma from the lower epidermis showing spinuous projections in the outlines of guard cells as seen in a mount with the inner side upwards,  $\times 455$ . Fig. 2. *Macrozamia secunda*. Lower epidermis showing papillae near end walls of ordinary epidermal cells and also in the encircling cells around a stoma,  $\times 312$ .

crystalliferous cells in the epidermis of the pinnæ of *M. cylindrica*, *M. communis*, *M. fawcettii*, *M. moorei* and *M. reidleyi*. The leaflets of *M. cylindrica*, *M. moorei*, *M. reidleyi* and *M. secunda* are amphistomatic. All other species are hypostomatic although *M. hopei* and *M. macleayi* may show a few stomata on the upper surface of the basal region of a pinna which is decurrent with the rachis. The lateral lamellæ of guard cells in *M. hopei* show fine

judged only when the epidermal structure of its remaining uninvestigated species too has been described.

Dept. of Botany, D. DARSHAN PANT.  
Allahabad Univ., DEVENDRA DATT NAUTIYAL.  
Allahabad, January 25, 1963.

1. Thomas, H. H. and Bancroft, Nellie, *Trans. Linn. Soc. London*, 1913, Ser 8B, 155.
2. Pant, D. D. and Nautiyal, D. D., *Curr. Sci.*, 1963, 32, 232.
3. Haberlandt, G., *Physiological Plant Anatomy*, 1914,

### ON THE OCCURRENCE OF *OPHIOBOLUS GRAMINIS* SACC. IN INDIA

DURING the course of investigations on foot-rot of wheat the fungus *O. graminis* was isolated at Saugor. This fungus, which has been widely reported from other countries, was so far not known with certainty to occur in India though work on foot-rot of wheat has been done by a number of workers (Subramaniam, 1928; Dastur, 1937; Asthana, 1954-55). The occurrence of this fungus was suggested only once before by Padwick (1940) though not with certainty. During the present investigations a general survey of foot-rot of wheat was carried out at Saugor and all the connected organisms were isolated and experimented upon. The organisms which could be easily isolated were *Bipolaris bicolor* Shoemaker (= *Helminthosporium bicolor* Mitra), *Rhizoctonia solani* Kühn, *Rhizoctonia* sp. and *Sclerotium rolfsii* Sacc. On the other hand, *O. graminis* was isolated sparingly with ordinary methods. This fungus yielded to isolation only when a special technique was used. On account of this even in the present investigations the fungus was not isolated for a long time, because it was susceptible to other micro-organisms which overpowered it in the Petri-dishes and when mercuric chloride was used to kill the saprophytes the fungus itself often died. It was later observed that if instead of mercuric chloride, silver nitrate was used as surface-sterilizing agent, *O. graminis* could withstand it well while other saprophytes dwindled out. By this process the fungus was easily isolated time and again and was found to be widely prevalent in the fields.

The fungus produces typical symptoms of whiteheads. The plants remain thin and weak and present a bleached appearance bearing empty earheads. The root system on examination shows black lesions with superficial dark runner hyphae. These lesions make the roots fragile thus making complete excavation difficult. This symptom was usually attributed to insect attack.

The fungus also produces symptoms at the early seedling stage, when the infected plants show general weakness, stunting and the leaf tips become yellowish to reddish-brown. The discoloration travels down and in the course of time the young plant may die. The roots of such plants are almost black and show black lesions with typical superficial dark runner hyphae. These symptoms on seedlings were first observed in the experimental pots when inoculation was given artificially; but later they were confirmed in the fields also.

The fungus did not produce any perithecia during its three years of study but it produced the typical runner hyphae.

The author wishes to express his gratitude to Dr. S. B. Saksena for his guidance, and to Dr. S. D. Garrett of Cambridge University for confirming the identification, and to the Ministry of Education, Government of India, for financial assistance.

Department of Botany,  
University of Saugor,

V. R. GHURDE.

Saugor (M.P.), December 24, 1962.

1. Asthana, R. P. and Narke, R. A., *Summary and Progress Report of the Scheme for Research on Foot-rot Disease of Wheat in M.F., 1954-55*, I.C.A.R., New Delhi.
2. Dastur, J. F. *Handbook of Plant Diseases of Economic Importance in C.P.*, Department of Agriculture, C.P. and Berar. Bulletin No. 28, 1937.
3. Davies, F. R., *Canad. J. Res.*, 1935, **13** (3), 168.
4. Padwick, G. W., *Curr. Sci.*, 1940, **9**, 179.
5. Subramaniam, L. S., *Agri. Res. Inst. Pusa, Bull.*, 1928, **177**, 1.

### LYCOPERDON PUSILLUM BATSCH. IN THE PUNJAB PLAINS— A NEW RECORD IN INDIAN GASTEROMYCETES

DURING the monsoon of 1962 a species of *Lycoperdon* was collected in July from meadows of Ludhiana. Continuous humid and rainy weather for more than two days seems to be highly favourable for the appearance of this species. The current literature on the Gasteromycetes shows that the species is a new record in India.

*Lycoperdon pusillum* BATSCH.

Fructifications small, 10-24 mm. thick, depressed-globose scattered on grassy grounds attached by bysoid or thick mycelial strands. Colour white when young. Surface of peridium covered with fine depressed white warts and peridium turns yellow when bruised or warts removed. At maturity the colour of surface of peridium becomes olivaceous yellow. Peridium thin and delicate. Gleba white when young and turns olivaceous at maturity and fills the entire peridium. Sub-gleba or sterile base, columella, and radiating plates absent. The peridium is less than 1 mm. in thickness at maturity and breaks at the top to form irregular or circular hole to release spores. The fructification shrinks after the release of spores.

Spores olivaceous in colour, spherical, 3-4 microns in diameter with a large oil drop. Capillitium smooth, long, simple and less branched, pale in colour and 3-4 microns in thickness (Fig. 1).





FIG. 1. Photomicrograph of spores and capillitia,  $\times 420$ .

Collected from meadows, Ludhiana, July 21, 1962, D. S. Chahal, deposited at Herb. Crypt. Ind. Orient, New Delhi, Accession No. 27636.

The author is grateful to Dr. Alexander H. Smith, Director, University of Michigan Herbarium, Michigan, U.S.A., for his help in identification of the species, and to Prof. C. S. Paracer, for providing necessary facilities.

Plant Path. Lab., DEVINDER SINGH CHAHAL.  
Govt. Agricultural College,  
Ludhiana, Punjab,  
December 19, 1962.

1. Butler, E. J. and Bisby, G. R. (Revised by Vasudeva, R. S.), *The Fungi of India*, I.C.A.R., New Delhi, 1960.
2. Coker, W. C. and Couch, J. N., *The Gasteromycetes of the Eastern United States and Canada*, Chapel Hill, The University of North Carolina Press, 1928.

#### A NOTE ON THE OCCURRENCE OF *CERCOSPORA OCIMICOLA* IN INDIA

DURING a survey of the parasitic fungi near-about Gorakhpur (U.P.), *Cercospora ocimicola* Petrak et Ciferri was collected in November 1961 on living leaves of *Ocimum sanctum* L. It has earlier been collected on *Ocimum micranthum* Willd. and *O. basilicum* L. from San Domingo and Formosa. Dr. Hopkins, Director, Commonwealth Mycological Institute, has informed the authors in a personal communication that there is a collection of *C. ocimicola* from Sudan also in the herbarium of CMI. So far this species has not been collected from India and *Ocimum sanctum* L. is being reported as a new host species of *C. ocimicola*.

The infected leaves show indistinct yellowish areas on the upper surface, the corresponding lower surface being olivaceous to greyish-brown, but much more effuse than in the type and in the collection from Sudan. The spots in the present collection are not vein limited.

Mycelium endophytic, conidiophores emerge in groups through the stomata on both sides of the leaf but in larger number on the lower surface, simple or occasionally branched, septate, very light brown, pointed at the conic tip,  $3.0-4.5 \times 15-58 \mu$  (Fig. 1a). Conidia narrowly obclavate, tapering towards the tip, light coloured, 2-14 septate.  $28-164 \mu$  long and  $2.0-3.2 \mu$  wide at their thickest part (Fig. 1b).

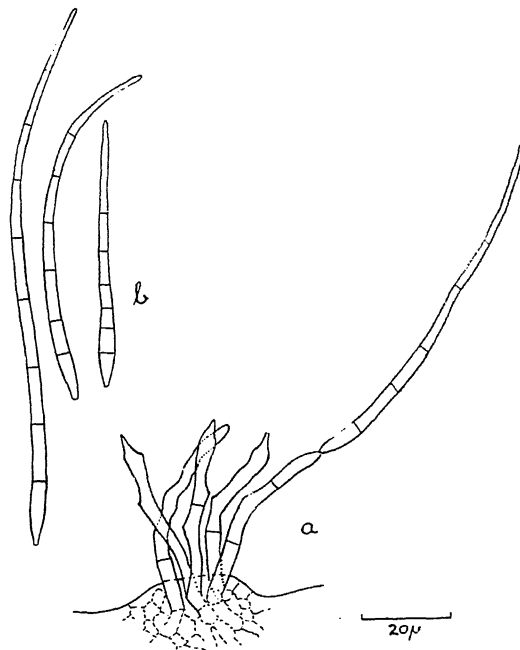


FIG. 1. (a) Conidiophores emerging from the leaf. (b) Conidia.

Chupp<sup>1</sup> has stated that a Sawada collection of the material (*C. ocimi* Sawada) is deposited in the U.S. Department of Agriculture Mycological Herbarium, but the literature is unknown.

The dried specimens have been deposited at the Commonwealth Mycological Institute, Kew, England, as IMI 90081 and in the Botany Department, Gorakhpur University, Gorakhpur.

The authors wish to thank Dr. J. C. F. Hopkins and Mr. F. C. Deighton of the Commonwealth Mycological Institute, Kew, England, for helpful suggestions.

Botany Department, P. C. MISRA.  
Univ. of Gorakhpur, K. S. BHARGAVA.  
Gorakhpur (U.P.), December 24, 1962.

1. Chupp, C., *A Monograph of the Fungus Genus Cercospora*, Ithaca, New York, 1953, pp. 577.

## REVIEWS

An Introduction to the Chemistry of Complex Compounds. By A. A. Grinberg. Translated from the Second Russian Edition (1951) by J. Rovtar Leach; Edited by Drs. D. H. Busch and R. F. Trimble, Jr. (Pergamon Press, London), 1962. Pp. xxi + 363. \$ 15.00.

The book is mainly devoted to classical co-ordination chemistry and deals with the preparation of traditional complex compounds, nomenclature, stereochemistry, methods for the resolution of optically active isomers, relation between the structure and optical rotatory power, conductivity, acid-base properties, polynuclear, inner and super complex compounds, study of equilibria by pH measurement and substitution reactions. The treatment of magnetic moment in relation to bond type of complex compounds is, however, sketchy. The technique of X-ray diffraction in establishing geometric isomers and bond lengths is not adequately described. The recent developments in the complex compounds of cyclopentadienyl and unsaturated hydrocarbons, the electronic and molecular spectra, and thermochemistry of complex compounds do not find a place in the book.

The complex formation is explained on the concept of electrostatic theory taking into consideration the polarisation phenomenon. The molecular orbital theory and the ligand field theory are not employed for this purpose. Omission of the ligand field theory and some of the recent developments in complex compounds can be understood since the book is a translation of the 1951 edition of the Russian text.

The book is attractively and carefully printed but some typographical errors have crept in, on pp. vii, xx, 7, 13, 38, 69, 71, 90, 91, 145, 170, 355, etc.

The book gives a glimpse through the evolution of co-ordination chemistry giving greater prominence to the contributions by Russian chemists, although one would normally expect due representation to scientific knowledge and developments from any part of the world. Nonetheless, the book provides considerable material for teaching and investigations by recent techniques. The book is a welcome addition to the scientific literature.

The translation is excellent and the editors have given their comments and notes at several

places in the light of recent developments. A supplementary bibliography for more recent treatment of the subject-matter discussed in the book is also provided in the English edition.

C. C. PATEL.

Gas Chromatography—Principles, Techniques and Application. By A. B. Littlewood. (Academic Press, New York and London), 1962. Pp. xi + 514. Price \$ 15.00.

The phenomenal growth of gas chromatography as a major analytical tool in research and industry during the course of a decade has made it difficult to give a comprehensive and systematic treatment of the subject. It is customary, therefore, to publish the proceedings of the periodical conferences of active workers in this field. A stage has now been reached, when it should be possible to take a closer look at the principles of the art and use it as a guide for future development.

The aim of the book, according to its author, is "to present a self-contained description of all aspects of gas chromatography". It is the opinion of the reviewer that this aim has been adequately and effectively fulfilled. The book has been logically and thoroughly planned and admirably executed.

Of the eleven chapters in this book, the first five deal with the principles: Definitions and technical terms, Retention volume and column variables, Retention volume and thermodynamic variables, and Fundamentals of column performance mechanisms. In Chapter 6, the preparation and use of columns are discussed. The performance of columns under isothermal and programmed temperature conditions and under the influence of other variables is treated clearly. Chapters 7, 8, 9 and 10 deal with detectors of different types. The last chapter discusses the application of gas chromatography and is particularly useful to a large number of research workers in varied fields, whose interest in the subject is limited to the ability to solve their analytical problems.

The book is written with clarity and with a theoretical bias. This is a desirable feature and may help to redress the imbalance created by unavoidable emphasis on techniques and applications in most other books. The serious student of gas chromatography and of partition equilibria, whether he is a physical chemist or

a chemical engineer will find the book invaluable. The book can unhesitatingly be recommended for all chemistry libraries.

M. V. BHATT.

International Series of Monographs on Nuclear Energy: *Reactor Safeguards*. By Charles R. Russell. Pp. ix + 390. Price 80 sh.; *Introduction to Structural Problems in Nuclear Reactor Engineering*. Edited by J. R. Rydzewski. (Pergamon Press, Oxford), 1962. Pp. ix + 404. Price 84 sh.

The *International Series of Monographs on Nuclear Energy*, published by the Pergamon Press under the General Editorship of J. V. Dunworth, attempts at giving up-to-date information on all aspects of the development of nuclear energy for peaceful purposes. These excellently produced volumes are issued from time to time under a number of classified Divisions such as Economics and Law, Nuclear Physics, Isotopes and Radiation, Health Physics, Medicine, Reactor Engineering, Reactor Design, Plasma Physics, etc. Already seventeen monographs have come out in this series, five of which are from the Division of Nuclear Physics and five from the Division of Reactor Design Physics. Scientists actually connected with the various disciplines of nuclear energy study are responsible for the collection and presentation of data. As such these volumes have made themselves indispensable to nuclear scientists, engineers and technologists, and each new volume in the series is eagerly looked for.

*Reactor Safeguards* is the first volume to be issued from Division XI—Reactor Operational Problems. The author Charles R. Russell served as Secretary first, of the Reactor Safeguards Committee, and later, of the Advisor Committee on Reactor Safeguards. In this privileged position he could gather valuable and authentic details on problems of reactor safeguards for a period which extended over several years, and the information thus accumulated formed the basis of lectures on reactor safeguards delivered at the North Carolina State College. Thus this compilation forms an extremely useful record on safe reactor operations.

The author presents the material under the following chapter headings: radioactive materials, reactor kinetics, control and safety systems, containment, safety features of water reactors, dispersion of radioactive materials, extent of possible damages, site requirements, and operating experience. In the last chapter on Operating Experience, the author narrates

27 reactor accidents which include the Windscale incident and the SL-I Reactor accident of 1960 at Idaho. Eleven of these accidents are criticality accidents. The author discusses how investigations of these accidents have helped formulating laws and regulations for their non-recurrence and for ensuring further safety in reactor operations.

*Introduction to Structural Problems in Nuclear Reactor Engineering* is the second volume to be issued from Division VII—Reactor Engineering. Nuclear Reactor Engineering has got specialised problems of its own. With the growth in size and complexity of reactors new problems crop up, and the tackling of these require on the part of structural engineers specialised knowledge which the "traditional" structural engineers normally do not get the opportunity to become aware of. To overcome this handicap and to draw the attention of all engineers to the theoretical problems specially involved in nuclear reactor engineering, a course of lectures was organized at Southampton University in the spring of 1960. The team of lecturers drawn from British Universities and engineering establishments was retained for the preparation of this volume, making full use of the experience gained during the course.

The first three chapters are of a general nature and define the problems that have to be solved in the light of physical, metallurgical and constructional requirements. The six chapters that follow give an up-to-date introduction to the analytical and computational techniques which can be used to solve the various problems. The next three chapters are respectively on the Direct Design of Grillages, Reactor Pressure Vessels Analysis, and Gas Duct Flexibility Analysis. In these experienced designers from the nuclear reactor industry outline the methods they favour for the design of different reactor components. The last chapter discusses the use of experimental stress analysis.

A. S. G.

*Fields and Circuits in Electrical Machines*. By N. Kesavamurthy and R. E. Bedford. (Thacker, Spink and Co., Calcutta), 1963. Pp. 384. Price Rs. 20.50.

The aim of the authors is to present an integrated account of magnetic field theory with special reference to electrical machine problems, so that the book could serve as a textbook for a post-graduate course in Electrical Machine Design.

The book begins with a good introduction to the fundamentals of magnetic field theory.

Chapter I introduces electrical machine theory from an electromagnetic standpoint, while Chapter II leads to the formulation of Laplace's and Poisson's equations. Chapters III through VII constituting Part I discuss various standard techniques for the solution of two-dimensional field problems, such as method of images, separation of variables for direct solution of Laplace's and Poisson's equations, conformal mapping, relaxation methods and other graphical flux plotting methods. Chapters VIII through XIII, constituting Part II, deal with the evaluation of synchronous and induction machine parameters using the methods presented in Part I. The book concludes with Part III covering the published work of the authors relating to time varying magnetic fields in ferromagnetic cores, and deals with problems such as flux penetration, pole-face losses, eddy current loss in laminations and transient fluxes in solid cores.

Some of the attractive features of the book include (a) A careful and complete discussion of basic physical concepts and (b) a broad and detailed coverage of important applications with illustrative examples.

Problems collected at the end of the book add to its usefulness. The book deserves a rightful place on the shelf of every student of electrical engineering who has to grapple with boundary value problems in electrical machinery.

The printing and get-up of the book are good and considering the abundance of material presented, the price is reasonable.

H. N. RAMACHANDRA RAO.

**Engineering Thermodynamics.** By E. F. Pickerill. (Cleaver-Hume Press, London), 1963. Pp. xii + 308. Price 32 sh. 6 d.

This book is meant for students preparing for undergraduate examinations in Engineering. The arrangement of the subject-matter is on orthodox lines. However the following additions in the several chapters have made this book more up-to-date and broad-based.

Rotary displacement and aerodynamic compressors, test equipment and procedure for I.C. Engines, I.C. turbine plants, heat pump and heat transfer.

The material for examples is taken from current practice and the examples are therefore more useful and give a more realistic picture of the subject. The author has succeeded in introducing the new student into the field of engineering thermodynamics with the help of this book.

M. R. K. RAO.

**Hydraulics.** By N. S. Govinda Rao. (Asia Publishing House, Bombay), 1962 Pp. xvi + 412. Price Rs. 22-00.

A new book on hydraulics requires some explanation regarding the nature of the attempt. The shortcomings of many books are that the exact purpose for which it is written is not kept in front by the author. Professor Govinda Rao has unlike others clearly stated the objectives, which have been completely fulfilled in the book.

The author has developed the subject from first principles and at every stage the physical concepts have been clarified in detail. The rich practical experience of the author has also been brought to bear in discussing various topics. The portion of hydraulic machines will be found to be especially useful to engineering students. A number of solved examples illustrate the methods of attack in solving problems. The book will serve as an excellent text-book at the University level.

V. M. DOKRAS.

**The Diagnosis of Mineral Deficiencies in Plants by Visual Symptoms** (3rd Edition). By T. Wallace. (Her Majesty's Stationery Office, London), 1961. Pp. vii + 125. Price 63 sh.

There is no disputing the fact that accurate diagnosis is the essential prerequisite to remedial treatment of any malady, be it in an animal or in a plant. Indeed, in the plant world, visual symptoms (which are but the external manifestations of internal disorders) are very often the first indication that the plant is diseased. If, then, visual symptoms can aid in specific identification of diseases, its practical usefulness should be self-evident, because it would be the quickest method of diagnosis.

Unfortunately, however, plants have only limited ways of expressing deviations from their norm though the basic causes may vary, and similar symptoms are noticed in plants suffering from different diseases, such as, for instance, the vein-clearing or yellowing symptoms in certain virus diseases, mineral deficiency or excess diseases and some vascular wilts in their early stages. The author has not overlooked this fact and has justly discussed the limitations as well as the advantages of the visual method of diagnosis of mineral deficiencies. He has rightly pointed out that this method is to be used 'in conjunction with other methods'. Among the methods described in the text, the rapid chemical tissue tests are bound to be of great value. The *Aspergillus niger* bio-assay method is now well known for

its sensitivity and simplicity and has been widely used for analysis of certain metals in soils and plant material. This section is a thoughtful and welcome addition in the present edition. In later editions, perhaps, the inclusion of some simpler methods of purification of the basal medium, involving lesser number of reagents and glassware, such as the alumina adsorption method of Donald *et al.* (*J. gen. Microbiol.*, 1952, 7, 211-220), would be helpful, since the number of possible sources of metal contaminations will be less.

For visual diagnosis, no amount of wordy descriptions can compare with actual seeing of symptoms. The 300 and odd colour photographs given for ready reference in this book fully justify its title and its purpose of serving not only the agricultural advisory officers and research workers, but also the practical farmers and gardeners. Although it would appear difficult for a novice to make the 'approximate identification' (for which the plates are meant) of the various mineral deficiencies from visual symptoms, because of the similarity of symptoms in certain cases, with a little practice and experience it should be possible to master the art. That the book is now in its third edition is proof of its usefulness. We hope later editions would include a greater number of crop plants and deficiencies.

T. S. S.

---

**Advances in Food Research**, Vol. 11. Edited by C. O. Chichester, E. M. Mrak and G. F. Stewart. (Academic Press, New York and London), 1962. Pp. ix + 454. Price \$ 14.50.

The present volume, 11th in the series of *Advances in Food Research*, contains six critical reviews covering a wide range of subjects such as food chemistry, food biochemistry, food technology, food microbiology and food engineering. The contributors to this volume have maintained the very high standard of this series.

M. A. Joslyn has presented an excellent review of the present knowledge regarding the chemistry of protopectin. The review deals with the following aspects such as preparation, analysis, characterisation, chemistry, etc. The problems for further study are also indicated.

M. Glucksman gives a critical review on "Utilization of Natural Polysaccharide Gums in the Food Industry". The review covers several important gums commonly used in the food industry indicating problems for further research.

W. H. Stahl has reviewed critically and extensively the important subject of "The Chemistry of Tea and Tea Manufacturing". The review deals with topics such as methods of tea manufacture, chemical constituents of raw and processed tea leaves, changes in chemical composition during manufacture, evaluation of quality in tea, and the use of isotope in tea research. The author has indicated several problems requiring further research.

L. Acker has dealt with the important subject of "Enzymic Reactions in Foods of Low Moisture Content" which is a subject of great importance to the food industry as a whole. The author has critically discussed the various aspects of the problem such as specific enzymic changes in foods with low moisture contents, role of humidity and temperature on the enzyme activity, and inactivation of enzymes present in low moisture foods and has also indicated the problems requiring further study.

I. Bosund has reviewed the subject "The Action of Benzoic and Salicylic Acids on the Metabolism of Micro-organisms". The topics covered include the factors influencing the growth-inhibiting effect of these acids on micro-organisms, mechanism of inhibition, inhibition of cell-free enzymes and problems for further study.

S. E. Charm has given a masterly account of the subject of "The Nature and Role of Fluid Consistency in Food Engineering Application", which will be of considerable interest and value to Food Engineers.

The present volume also includes an 'Index of contributors' and a 'Cumulative subject index' to Vols. I-X.

This publication will serve as an authoritative volume of reference to all advanced students and research workers in the field of Food Science and Technology.

M. SWAMINATHAN.

---

**Symposium on Muscle Receptors**. Edited by D. Barker. (Hong Kong University Press; Oxford University Press, Mount Road, Madras-2), 1962. Pp. vii + 292. Price Rs. 66-00.

This symposium consists of the proceedings of a meeting held in September 1961 as part of the Golden Jubilee Congress of the University of Hong Kong. Muscle is a very important organ, and it is said "to move the world"; it is, therefore, necessary to know about it as much as possible. Most of the symposium has been devoted to the anatomy and physiology of the muscle spindle. One may think it is a very minor subject for a symposium, but owing to

the importance of muscle, the muscle spindle also assumes great importance; as a matter of fact one should know as much about it as one knows about the retina or the internal ear. This symposium has actually brought out such information, and this has been one of the main features of the meeting.

The receptors in the muscle has been given an increasing amount of attention during the last two decades. The subject has expanded so much and specialisation has advanced to such a stage that it is no longer possible for the same person to deal with both the structural and functional aspects adequately in this field. Thus there was a need for a greater exchange of information and ideas between neurophysiologists and neuroanatomists, and the symposium had more than fulfilled this need. Twenty-two papers and three special lectures were communicated at the symposium and there were also three recorded discussions and two laboratory demonstrations. The symposium may be considered as very successful.

INDERJIT SINGH.

**Section Cutting in Microscopy.** By H. F. Steedman. (Blackwell Scientific Publications, Oxford), 1960. Pp. 172. Price 21 sh. net.

The first sections were made by Stilling in 1842 from a spinal cord frozen overnight on the window-sill of his laboratory. The gradual improvements incorporated since then in microtomy have led to advances in such diverse disciplines as histology, pathology and cytology. The introduction of the electron microscope and the improvements in its resolution necessitated adaptation of known techniques to obtain ultrathin sections. The resolution of the electron microscope is roughly 1/10th of the thickness of the object. The present volume gives detailed information on section-cutting techniques and would be of practical value to investigators in several disciplines.

M. K. S.

#### Books Received

From: (Addison-Wesley Pub. Co., Mass., U.S.A.):

*Modern Multidimensional Calculus.* By M. E. Munroe. Pp. viii + 392. Price \$ 9.75.

*An Introduction to Digital Computing.* By B. W. Arden. Pp. ix + 389. Price \$ 6.50.

*General Stochastic Processes in the Theory of Queues.* By V. E. Benes. Pp. viii + 88. Price \$ 5.75.

*An Introduction to Plasma Physics.* By W. B. Thompson. Pp. viii + 256. Price \$ 10.00.

*Numerical Solution of Ordinary and Partial Differential Equations.* By L. Fox. Pp. ix + 509. Price \$ 10.00.

*Generalized Analytic Functions.* By I. N. Vekua. Pp. xxix + 668. Price \$ 14.75.

*Physical Geochemistry.* By F. Gordon Smith. Pp. x + 624. Price \$ 15.00.

*Reaction Heats and Bond Strengths.* By C. T. Mortimer. Pp. xii + 230. Price \$ 5.00.

From: (Academic Press, Inc., 111, Fifth Avenue, New York-3):

*Methods in Carbohydrate Chemistry (III)—Cellulose.* Edited by R. L. Whistler. Pp. xvi + 407. Price \$ 15.50.

*The Bacteria (Vol. IV)—The Physiology of Growth.* Edited by I. C. Gunsalus and R. Y. Stanier. Pp. xiv + 459. Price \$ 16.00.

*Experimental Chemotherapy (Vol. I).* Edited by R. J. Schnitzer and F. Hawking. Pp. xv + 1008. Price \$ 38.00.

*Advances in Protein Chemistry (Vol. XVII).* Edited by C. B. Anfinsen Jr., M. L. Anson, K. Bailey and J. T. Edsall. Pp. xvi + 412. Price \$ 14.00.

*Comparative Nutrition of Man and Domestic Animals (Vol. I).* By H. H. Mitchell. Pp. xxi + 701. Price \$ 25.00.

*Analytical Microbiology.* Edited by F. Kavanagh. Pp. xvi + 707. Price \$ 22.00.

*Advances in Heterocyclic Chemistry (Vol. I).* Edited by A. R. Katritzky. Pp. xi + 476. Price \$ 15.00.

*Methods of Experimental Physics (Vol. 5)—Nuclear Physics (Part B).* Edited by L. C. L. Yuan and Chien-Shiung WU. Pp. xviii + 886. Price \$ 22.50.

From: (Asia Publishing House, Calicut Street, Bombay-1):

*Complex Numbers and Functions.* By T. Estermann. 1962. Pp. xiii + 250. Price Rs. 14.00.

*Advanced Materials—Refractory Fibres, Fibrous Metals, Composites.* By C. Z. Carroll-Porczynski. 1962. Pp. 286. Price Rs. 32.00.

## SCIENCE NOTES AND NEWS

### Award of Research Degrees

The Karnatak University, Dharwar, has awarded the Ph.D. degree in Physics to Shri B. G. Jyoti for his thesis entitled "Band spectra: Some Investigations on Problems of Active Nitrogen".

Osmania University has awarded the Ph.D. degree in Zoology to Shri Anand Kumar Jaiswal for his thesis entitled "Studies on the Morphology and Physiology of the Reproductive System of the Cockroach *Periplaneta americana* L."

Andhra University has awarded the D.Sc. degree in Chemistry to Shri S. Seetharamaraju for his thesis entitled "Some Aspects of the Analytical Chemistry of Molybdenum and Uranium"; and the Ph.D. degree in Geo-physics to Shri M. P. Madduleti Reddy for his thesis entitled "Limnological Studies of the Chilka Lake and Wave Refraction Studies in Relation to Shoreline Development".

### Raptakos Medical Research Board Fellowships for 1964

The Raptakos Medical Research Board will consider applications for the award of Fellowships for research work on medical and allied subjects in recognized institutions situated in the Union of India.

The awards normally consist of: (a) Rs. 3,000 per year for a Fellowship and Rs. 750 per year towards contingencies approved by the Board; and (b) Rs. 6,000 per year for a Fellowship and Rs. 1,000 per year towards contingencies approved by the Board.

Applications in the prescribed form, which may be obtained from the Secretary and Treasurer, Raptakos Medical Research Board, Dr. Annie Besant Road, Worli, Bombay-18, should reach him before September 30, 1963.

### Lady Tata Memorial Trust Scholarships and Grants for the Year 1963-64

The Trustees of the Lady Tata Memorial Trust announce on the death anniversary of Lady Meherbai Dorabji Tata, 18th June 1963, the awards of scholarships and grants for the year 1963-64.

International Awards of varying amounts (totalling £ 6,037) for research in diseases of the blood with special reference to Leukæmias are made to:

Dr. B. Lagerlof (Sweden), Dr. R. L. Blakley (Australia), Dr. S. Itzhaki (England), Dr. B. Pedersen (Denmark), Dr. J. H. Hale (Great Britain), Dr. K. M. Laurence (England), Dr. Jacqueline de Maeyer (Belgium).

Indian Scholarships of Rs. 250 per month each for one year for scientific investigations having a bearing on the alleviation of human suffering from diseases are awarded to:

Mr. V. N. Gogte (Bombay), Dr. V. N. Ingle (New Delhi), Miss P. Malathi (Bangalore), Dr. Farooq Ashai (Patna), Dr. K. L. Batra (New Delhi), Dr. (Miss) G. Grewal (Calcutta), Dr. V. N. Sehgal (New Delhi).

### The Matric Computer

The Matric Computer is a new electronic machine for the solution of problems in matrix mathematics, such as the inversion and multiplication of numerical matrices; the evaluation of numerical determinants; and the solution of algebraic and differential equation systems. The new computer designed by Prof. P. M. Honnell of Washington University also solves all problems normally associated with analogue computers and differential analyzers, but unlike these it has no patching panels.

The theoretical basis of the machine rests upon the synthesis of an admittance network. Its information content is represented by an ensemble of digitally controlled admittances permanently interconnected through a system of entry and trace amplifiers; prescribed mathematical constants of functions are represented by current-sources. In the synthesis network, of fixed configuration, the digitized admittances represent the entries in the problem matrices, and are in a 1-to-1 reciprocal correspondence with the matrix mathematics. The dynamic equilibrium voltage responses of the network automatically yields the solution-vector of the matrix problem being solved.—(*Washington University News*.)

### Origin of the Earth's Magnetic Field

That the earth's magnetism may well be due to a high-pressure magnetic phase of iron in the central core of the earth has been suggested by R. J. Weiss in a communication to *Nature* (1963, 197, 1289). The earth's core which extends outwards from the centre to a distance of some 3,450 kilometres (radius of the earth is

6,350 km.) is believed to be predominantly iron. It can be divided into two distinct parts, namely, the outer core which is liquid since it does not transmit transverse seismic waves, and the inner one supposed to be solid whose structure is still in doubt. According to Bullen the interface between the inner and the outer cores occurs at a depth of about 5,000 kilometres, corresponding to a pressure of about  $3.3 \times 10^{12}$  dynes/cm.<sup>2</sup>, and a temperature of 4000° K. It has been estimated that the density on the outer liquid side of the interface is 11.5 gm./cm.<sup>3</sup>, and that on the inner solid side 15.2 gm./cm.<sup>3</sup>. This density change of nearly 30% is too large to be adequately explained if we consider that the change in the density of iron on melting is only 3.5%.

R. J. Weiss suggests that the inner core of the earth may well be a new phase of iron in which two of the 3p 'argon core' electrons are transferred to the '3d-4s' band and that such a phase may account for the origin of the earth's magnetic field. The transfer of two of the 3p electrons to the '3d-4s' band would add two more electrons to the six bonding electrons (the two magnetic electrons are in the anti-bonding states), and in analogy to the cases, of the rare earth metals cerium, europium, and ytterbium, this would change the atomic volume approximately in proportion to the number of overlapping electrons. In iron this new high-pressure phase would correspond to a density change of about 25%.

If the onset of the high-pressure magnetic phase of iron is supposed to take place at the pressure of  $3.5 \times 10^{12}$  dynes/cm.<sup>2</sup>, then the following consequence arises regarding the magnetic fields of planets. If the planets contain cores similar in composition to the earth only those of mass approximately equal to or greater than the earth would develop sufficient gravitational pressure to create the high-pressure magnetic phase. Thus one would expect magnetic fields only in the case of the major planets Uranus, Neptune, Saturn and Jupiter, and no magnetic fields on Mercury, Mars, Venus and the Moon.—(*Nature*, 1963, 197, 1289.)

**Simultaneous Occurrence of *Corynebacterium tritici* (Hutch.) Burkholder and *Ustilago tritici* (Pers.) Rostr. in the Same Ear of Wheat**

Messrs. S. C. Mathur and Z. U. Ahmad, Section of the Plant Pathologist, Uttar Pradesh Government, Kanpur, write :

Combined infection caused by *Corynebacterium tritici* (Hutch.) Burkholder and *Ustilago*

*tritici* (Pers.) Rostr. in the same ear of wheat variety Pb. 591 was observed recently at the time of its emergence at the Government Research Farm, Kanpur. Five other smutted ears in the same plant showed neither the association of the nematode, *Anguina tritici* (Steinbuch) Filipjev nor the bacterium. The association of two unrelated pathogens, viz., a bacterium (*C. tritici*) and a fungus (*U. tritici*) seems to be a new record.

#### Report of the National Chemical Laboratory, Poona, 1950-60

The National Chemical Laboratory, Poona, is among the first in the chain of research laboratories set up by the Council of Scientific and Industrial Research, New Delhi. It was declared open on January 3, 1950, and the Report, the first to be issued since then, reviews the progress of research that has taken place in the laboratory during the ten years 1950-60. In this period about 500 papers have been published giving the results of the laboratory's activities in the various branches of study. The choice of problems has been guided by the country's needs of chemical products and also by the specialized knowledge and interests of the working members of the staff. The report shows that 95 patents have been taken during the decade. It will be a welcome feature if the proposed idea of issuing an annual report reviewing the activities and achievements of the NCL during the year concerned is put into effect.

#### Indian Livestock

"*Indian Livestock*" is a quarterly journal that is being brought out by the Indian Council of Agricultural Research (ICAR), New Delhi. In a country which is predominantly agricultural livestock occupy a very important place in the national economy. With the successive Five-Year Plans being implemented by the Government there is a phased programme of research in the various aspects of livestock science such as breeding nutrition, control of diseases, production of dairy products, etc. It is necessary that the results of these researches should reach the man in the field, and this popular journal will go a long way in fulfilling this object.

The first number of the journal (January 1963, 64 pages) contains a number of popular articles on Cattle and Buffaloes, Poultry, Sheep, Fisheries, Dairying, Hides, Skins, and Leather; etc. A useful feature is 'Farm advice' which answers questions which will be of practical value to farmers regarding their day-to-day farm problems.



The Annual subscription of the journal is  
Rs. 4.

### Cultivated Plants and Their Wild Relatives

In 1958 Academician P. M. Zukovskij published a Russian manual of about 600 pages on "Cultivated plants and their wild ancestors", for use in the faculties of Biology and Soil Science in the USSR State Universities. His long association with the unique collections of plants at the Institute of Plant Industry at Leningrad has made him eminently suited to write on the subject. Particular emphasis is placed on the importance of China, Southern Asia and Asia Minor as centres of cultivated plants and a large number of species that have originated there are enumerated in this manual. What the author says, particularly with reference to the origins of the various plants, is of wide interest to botanists throughout the world.

The Commonwealth Agricultural Bureaux has brought out an abridged translation of this work at a very reasonable price. The translation has been done by Dr. P. S. Huxton of the Commonwealth Bureau of Plant Breeding and Genetics. The crown quarto, paper-cover book is of 107 pages and is priced 10s. (U.S. \$1.50). It can be had from the Commonwealth Agricultural Bureaux, Central Sales Branch, Farnham House, Farnham Royal, Bucks.

### Ultrasonic Waves Rotated by Magnetic Field

Experiments at the Bell Telephone Laboratories have shown that the direction of polarization of transverse ultrasonic waves travelling in a crystal could be rotated by their interaction with a magnetic field. This work is significant because the rotation is non-reciprocal, that is, when the wave is reflected at the end of the crystal and travels back to the input it does not rotate back to its original direction of polarization. This envisages the possibility of a new family of ultrasonic devices such as circulators and isolators.

In the experiment a quartz disc is bonded to one end of a cylinder of single crystal yttrium iron garnet (YIG), and a dc magnetic field parallel to the axis of the cylinder is applied. The magnetic moments of the iron atoms in the garnet then line up parallel to the field. Next, piezoelectric oscillations are set up in the quartz disc generating an ultrasonic wave pulse. This 500 mc/sec. pulse is polarized parallel to the (100) quartz axis.

The ultrasonic pulse travelling down the garnet cylinder strains the crystal lattice so that

the iron atoms get alternately pulled apart from each other and squeezed together in a direction perpendicular to the magnetic field. Straining the atoms creates a second magnetic field, the *rf* field, which is perpendicular to the applied dc magnetic field. A component of the *rf* field interacts with the lined-up iron atoms and changes the direction of their magnetization. (This process is the inverse of magnetostriction whereby ferromagnetic materials elongate in the direction of a dc magnetic field and contract in a direction perpendicular to the field.)

The change in the direction of the magnetic moments of the iron atoms affects the direction in which they move as the pulse strains the YIG lattice. The motion of the iron atoms is linearly polarized in a plane perpendicular to the wave's direction of travel. The initial group of iron atoms move up and down in this plane. The next group of atoms move at an angle to the previous group in the perpendicular plane. This rotation is caused by the interaction of the *rf* field and the lined-up iron atoms and is analogous to the Faraday rotation of electromagnetic waves in ferrites. Each group of atoms is strained at an angle to the previous atoms strain and thus the direction of motion is rotated continuously. When the wave is reflected at the end of the YIG cylinder, rotation of the strain polarization continues in the original direction since the interaction between strain and the iron atoms is independent of the direction in which the wave travels.—(J. Frank. Inst., 1963, 275, 258.)

### Anhydrous Hydrazine—The New Space-age Fuel

The fuel that was instrumental in helping *Mariner II* reach Venus was anhydrous hydrazine, a relatively unknown space-age fuel. *Mariner II* was launched on August 27, 1962 (see *Curr. Sci.*, 1962, 31, 530). Eight days later it was travelling at 6,780 miles/hr. on a course that would have taken it to the distance of closest approach to Venus. The basic success of the probe hinged on a vital mid-course manoeuvre that had to be executed by remote control at a distance of 1,492,500 miles from earth. This was accomplished on September 4, 1962, when three coded commands were sent to *Mariner II* and stored in its command and control system. The first ordered it to roll 9.33 degrees; the second called for a pitch manoeuvre of 139.85 degrees; the third ordered the mid-course correction motor to burn for 29 seconds.

When receipt of the commands was verified, the Goldstone, California, tracking station

issued a signal executing the sequence of commands at specified intervals. The roll required 51 seconds, the pitch manoeuvre 13 minutes 15 seconds. The latter turned *Mariner II* almost completely around so that the 29 second motor firing acted as a retro-rocket slowing the craft by 69.5 miles per hour to make the course correction. That this correction succeeded was proved on December 14 about 3-00 p.m. (E.S.T.) when *Mariner II* passed within 21,000 miles of the cloud-covered Venus.—(*Jour. Frank. Inst.*, 1963, 275, 260.)

### Single Crystal Growth from Aqueous Solution

Those with an interest in the growth of large single crystals from aqueous solution will find useful information in an article on the subject by Torgesen *et al.* in the *Journal of Research Sec. C*, National Bureau of Standards (1963, Vol. 67 C, p. 25). The growing of large single crystals of high quality from solution requires the precise control of supersaturation and the avoidance of thermal and mechanical shock. In the equipment assemblies described in the paper, the crystal growth bath is designed for uniform growth conditions and the exclusion of contamination. The temperature controller gives regulation of the temperature an order of magnitude more sensitive than those hitherto used and provides for stepless change of temperature. The crystals are thus free from liquid inclusions found to result from sudden acceleration of growth.

With the assemblies described single crystals of ammonium dihydrogen phosphate, potassium dihydrogen phosphate, uranyl nitrate hexahydrate, strontium dichromate, sodium chlorate, sodium nitrate, and oxalic acid dihydrate have been successfully grown. The crystals have been judged excellent on the basis of tests by X-ray diffraction, optical examination between crossed polarizers, microscopic searches for discontinuities or inclusions, and the observation of reflections from cleavage surfaces.—(*Jour. O. Res., C, Nat. Bur. Std.*, 1963, 67 C, 25.)

### U.S. Astronaut Gordon Cooper

An Atlas rocket launched into orbit the space capsule 'Faith 7', carrying U.S. astronaut Leroy Gordon Cooper off Cape Canaveral on May 15, 1963, at 1-04 G.M.T. After completing the scheduled flight of 22 orbital rounds in 34 hours 21 minutes, Cooper, who piloted his spacecraft manually during the final re-entry stage, landed safely in the Pacific ocean at the marked spot within sight of his rescue ship. The orbit round the earth ranged from 100 miles to 165 miles high, and the period of revolution was 88 minutes 45 seconds. Cooper is the tenth man to rocket into space since the first Russian astronaut Major Yuri Gagarin who orbited once round on April 12, 1961.

### Second Russian Twin Cosmonauts in Space— First Woman Astronaut

Russia launched a spacecraft called Vostok V, carrying the 29-year-old astronaut Lt.-Col. Valery Federovich Bykovsky, on June 14, 1963, at 15-00 hrs Moscow time. Following this, two days after, on June 16, 1963, at 12-30 hrs Moscow time the spaceship Vostok VI was launched carrying the first woman astronaut, the 26-year-old Miss Valentina Tereshkova. According to official reports the two spaceships are orbiting the earth with only 12 seconds difference in their timing, Vostok VI taking the longer. All systems on board the spaceships have been functioning normally, and live TV transmissions from them have been observed on the Russian television network. The two pilots established radio contact with each other at 13-00 hrs Moscow time, 30 minutes after Vostok VI rose from the earth.

It will be recalled that the two spaceships, which were simultaneously in flight for the first time were launched on August 11 and August 12, 1962, carrying cosmonauts Nikolayev and Popovich who came close together while in orbit.—(*See Curr. Sci.*, 1962, 31, 360.)

# FLORAL COLOURS AND THE PHYSIOLOGY OF VISION

SIR C. V. RAMAN

THE world of flowers provides us with an illimitable variety of objects manifesting colour to our visual perceptions. How do these colours arise? The issues raised by this question would be regarded from entirely different points of view by men of science according to their professional interests. But the most fundamental issue of all is the relationship which exists between our visual perceptions and the spectral composition of the light which reaches our eyes from the material of the flower. This relationship can be studied by very simple methods which enable a great many cases to be rapidly surveyed and thereby permit of some conclusions of general validity to be reached. Such an investigation has occupied the author during these past few months and the results, which it has yielded are of extraordinary interest and importance. Indeed, it appears that a radical reconstruction of our ideas regarding the physiology of vision and the perception of colour is called for in the light of the facts revealed by the investigation.

The colours of the spectrum, in other words, the sensations excited in our visual organs by the monochromatic radiations into which white light is split by a prism or a diffraction grating, form the natural and indeed the most appropriate standard of comparison with any observed colour and therefore also the basis of the language in which any observed colour should be described. But the distinguishable colours of the spectrum are very numerous, and a further difficulty is raised by the fact that many observable colours appear to our perceptions to differ fundamentally from any of the pure spectral colours. In these circumstances, the question of terminology complicates the task of describing the results of a study which seeks to specify the relationship between any perceived colour and the spectral composition of the light which gives rise to that sensation. Fortunately, however, it turns out that this difficulty is not insuperable and that the results of the study can be set out in readily intelligible terms.

The sensation known as purple is one that is readily recognised by all who are familiar with the subject of colour and we shall therefore begin by considering the origin of this sensation as revealed by the present investigation. It is appropriate that we consider first the case of a plant which is accessible to the widest

possible circle of readers. Balsam is a well-known garden plant which also goes by the name *Impatiens* by reason of the violent discharge of its seeds from the pod when ripe. The flowers appear along the entire stem of the plant. One of the known varieties of balsam advertised in the seedsmen's catalogues bears purple flowers. Holding up the petals of this flower against the sky, a visual examination of the light emerging through it with a pocket spectroscope reveals that the petals exercise a powerful absorption in the spectral region between 560  $m\mu$  and 590  $m\mu$ , the strength of such absorption visibly increasing as we proceed towards greater wavelengths and being greatest at 590  $m\mu$ . In other words, the petal absorbs the yellow region of the spectrum strongly, whereas the rest of the spectrum is let through the different regions therein exhibiting the same relative intensities as in the incident light. Another method of examination is to view the petal in sunlight by reflection instead of by transmission. The spectrum seen in this way represents the colour of the flower more nearly than the spectrum observed by transmission. Actually, however, in the particular case, there is no noticeable difference in the characters of the observed spectra.

As another noteworthy example of a purple flower may be mentioned here the blooms of the great forest tree known as *Lagerstroemia Flos-Regina*, the striking beauty of which in the flowering months has led to its being planted extensively as ornamental trees in gardens and in avenues. There are two varieties of this tree, one of which bears purple flowers and the other rose-coloured ones. We shall return to the second kind later on. The flowers of *Lagerstroemia* have very thin and delicate petals, but their colours are extremely striking. The spectral behaviour of the purple variety is the same as that of the balsam flowers described earlier. This is also true of numerous other flowers which exhibit a purple hue to our visual perceptions. The well-attested fact thus emerges that the weakening or removal of the yellow sector of the spectrum between 560  $m\mu$  and 590  $m\mu$  from the light entering the material of the flower and re-emerging as scattered or diffused light results in the latter exhibiting to our visual perceptions the characteristic sensation of a purple colour.

In the foregoing paragraph, reference was made to the rose-coloured flowers borne by the second variety of *Lagerstroemia Flos-Regina*. Spectroscopic examination of these rose-coloured flowers reveals that their petals exercise an observable absorption in the spectral region between  $510\text{ m}\mu$  and  $570\text{ m}\mu$ , the maximum of absorption being at  $550\text{ m}\mu$ . There is no sensible absorption at wavelengths less than  $510\text{ m}\mu$  or greater than  $570\text{ m}\mu$ . In other words, the petals of the rose-coloured flowers present a sensible absorption in the green sector of the spectrum, but allow the violet and blue as well as the yellow, orange and red parts of the spectrum, to come through freely. The manifestation of a rose-red colour to our perceptions is thus associated with the spectral behaviour just mentioned.

A rose-red colour is exhibited by numerous other flowers. A highly significant fact which has emerged from the studies made by the author with such flowers is that the saturation of the observed hue increases *pari passu* with increasing strength of the absorption manifested in the green sector, the rest of the spectrum retaining its characteristic of free transmission. In other words, the more nearly complete the absorption of the green is, the more nearly does the observed hue approach a spectral red in its visual characters. This feature is noticeable with many flowers, a particularly remarkable fact being that their perceived colour is red, despite the fact that the spectroscope shows the blue of the spectrum appearing with undiminished intensity relatively to the red, orange and yellow parts of the spectrum. In some cases, indeed, the perceived colour is indistinguishable from a pure spectral red, but the spectroscopic examination shows the blue coming through with no observable diminution in its intensity.

The facts set forth above are so remarkable in themselves and so different from what the current beliefs regarding the origins of colour would indicate that it appeared desirable to present to the reader some evidence of an objective nature supporting the statements made on the basis of subjective observations. In the course of the author's investigations, indeed, numerous spectrograms were recorded of the light transmitted through various flower petals. A complication that presented itself in this work was the non-uniform sensitivity of the panchromatic film employed to record the spectrograms. This shows up as a very pronounced minimum of recorded intensity in the

green region. In consequence of this, the photographic record of the transmission spectra is not as satisfactory an indication of the real behaviour of the flower petal as could be desired. Nevertheless, the records are not altogether useless for the purpose in view.

Figure 1 in the accompanying reproduction exhibits three spectrograms recorded with three different exposures of the light of a tungsten filament lamp (filtered through  $\text{CuSO}_4$  solution) and transmitted through the petal of a purple balsam flower. Above them appears a comparison spectrum of the light source. The red end of the spectra appears at the extreme left in each case, while the blue and violet regions stretch out to the right. The sharp cut-off seen visually at  $590\text{ m}\mu$  and the rapid decrease in the absorption at smaller wavelengths are both clearly shown in the spectrograms.

Figure 2 reproduces the absorption spectra (recorded in a similar manner) of the petal of a polyantha rose. This was chosen for the reason that its red colour was of nearly saturated hue. On a comparison with Fig. 1, it will be seen that the absorption in Fig. 2 begins at a greater wavelength and extends over nearly the whole of the green sector. It is significant that the blue and violet regions of the spectrum appear in the transmitted light without any observable indications of absorption.

Numerous flowers the colour of which appears blue to our visual perceptions were also studied. It was a noteworthy fact that none of those so far examined exhibited any localised increase of intensity in the regions of shorter wavelengths in the spectrum. On the other hand, the spectroscope showed very clearly that the observed colour had its origin elsewhere in the spectrum. We may mention here three flowers exhibiting a blue colour which were studied in some detail, viz., the flowers of the avenue tree *Jacaranda mimosifolia*, the flowers of the climbing plant *Thunbergia grandiflora*, and the clusters of blue flowers of the well-known shrub *Plumbago capensis*. In each of these cases, the most conspicuous feature of the spectrum was an absorption band from  $560\text{ m}\mu$  to  $590\text{ m}\mu$  covering the yellow region. That this did not result in the flowers appearing of a purple colour is due to the fact that in each case, an additional absorption band was noticeable which diminished the observable intensity in the orange-red parts of the spectrum.

Of particular significance is the behaviour of the flowers of the climbing creeper known

Fig. 1

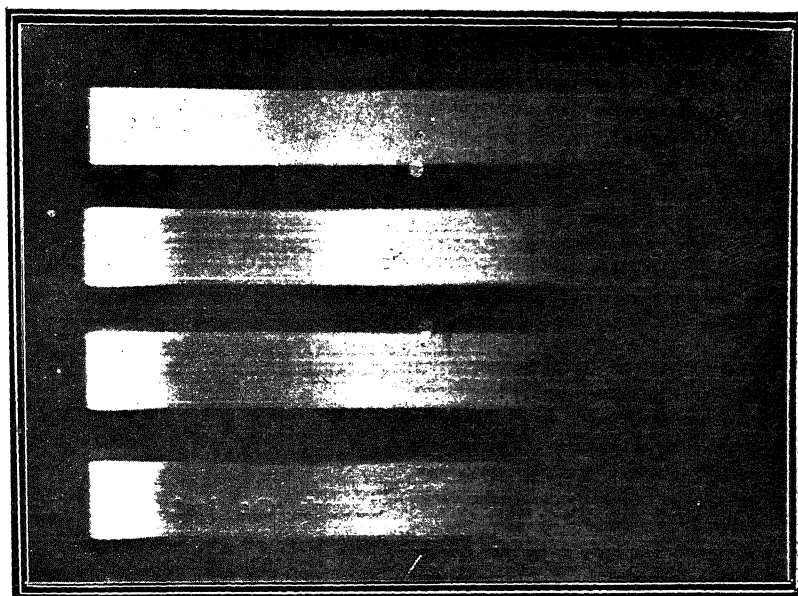


Fig. 2

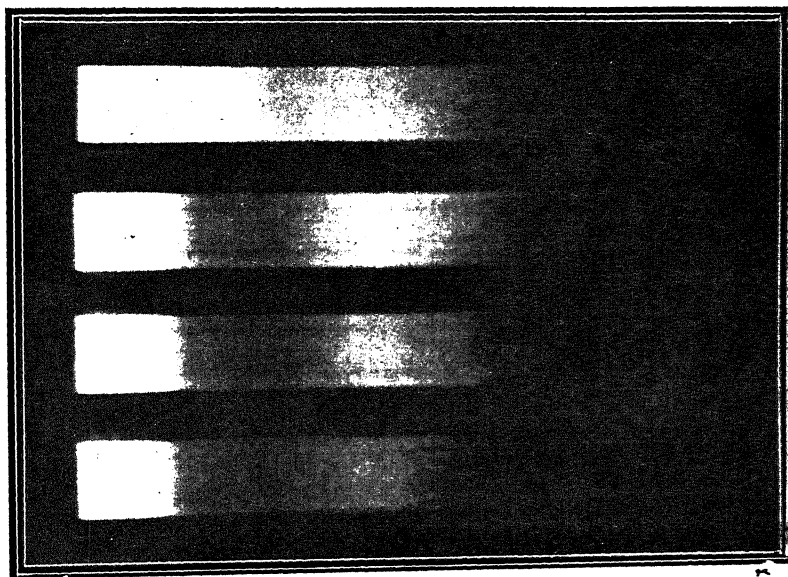


FIG. 1. Absorption Spectra of Purple Balsam (with comparison spectrum).

FIG. 2. Absorption Spectra of Red Rose (with comparison spectrum).

botanically as *Ipomea learii* and popularly as the "Morning Glory". The absorption of this flower appears in a restricted region of the spectrum, the wavelength region between  $560\text{ m}\mu$  and  $590\text{ m}\mu$  having a distinctly lowered intensity, while the region between  $590\text{ m}\mu$  and  $630\text{ m}\mu$  is strongly absorbed. In other words, the yellow and orange sectors of the spectrum are partly or wholly eliminated, but the violet, blue, green and red sectors appear with undiminished intensity. That in these circumstances, the flower exhibits a deep blue colour without even a trace of any achromatic sensation being overlaid on it is quite remarkable.

Another interesting case is that of the tree *Solanum grandiflorum* popularly known as the large-flowered nightshade or potato tree. Spectroscopic examination reveals that its flowers exhibit an absorption band covering the yellow region of the spectrum. This is indeed a characteristic feature exhibited by all the blue flowers so far examined by the author. That the *Solanum* flowers exhibit a highly saturated bluish-violet colour instead of appearing as purple may be ascribed to the presence of an additional absorption band in the orange-red which diminished the observable intensity of that part of the spectrum.

From the facts set forth above, it is clear that the yellow sector of the spectrum covering the small wavelength range between  $560\text{ m}\mu$  and  $590\text{ m}\mu$  plays an extraordinarily important role in the physiology of vision. Its presence in full strength, any reduction in its intensity, or its total extinction in the light from the object which reaches the observer's eye have enormous effects on the colour sensations experienced by him.

A detailed study has been made by the author of the origin of the characteristic green colour of vegetation. The usual explanation given of it is that the absorbing pigments present in green leaves eliminate the blue as well as the red parts of the spectrum, leaving us with the green, thereby accounting for the observed colour. Spectroscopic examination of the light which filters through green leaves shows this explanation to be untenable. The shorter wavelengths in the spectrum are indeed eliminated in the passage of light through a leaf, the carotenoid pigments playing the leading role in this respect. This is evident from the appearance of a fairly

well-defined absorption limit at about  $510\text{ m}\mu$ . On the other hand, the characteristic absorption bands of the chlorophyll pigments appear at the red end of the spectrum. The contribution of the extreme red to visual luminosity is quite small. Hence the absorption by the chlorophylls in that region can have no sensible effect on the observed colour of green leaves. Actually, the entire spectrum between the wavelength limits  $510\text{ m}\mu$  and  $650\text{ m}\mu$ , is transmitted. Hence, according to the ideas current at the present time, even a mature green leaf should appear of a golden yellow hue and not a bright green or a dark green as is actually the case.

The green colour of leaves thus confronts us with a basic problem in the physiology of vision. The clue to its solution is furnished by the fact that there is an observable diminution in the intensity of the yellow sector of the spectrum between  $570\text{ m}\mu$  and  $590\text{ m}\mu$  in its passage through the leaf. This diminution is just noticeable in the case of tender leaves exhibiting a green colour tinged with yellow. It is easily seen with mature leaves, which appear of a full green hue, while the absorption in that region is almost complete in the case of leaves exhibiting a dark green colour. It is clear that it is this absorption which determines the observed colour of the leaf. The rest of the spectrum between  $590\text{ m}\mu$  and  $650\text{ m}\mu$  which passes through the leaf and can be seen through a spectroscope appears to have no effect on the perceived colour of the green leaf.

The present communication is essentially a recital of facts. It is evident that these facts are irreconcilable with the idea that the colour sensations produced by polychromatic radiation can be computed by arithmetic or algebraic processes involving only additions or subtractions. It is clear also that they require an alternative approach in which the concept is introduced of the masking in certain circumstances of the sensations produced by one part of the spectrum by those produced by another part. With the aid of that concept, it becomes possible to understand why a flower may appear of a full red colour but that it nevertheless transmits blue light freely, or why again, a leaf appears green despite the fact that a great deal of red light passes through it unabsorbed. But we shall not enter here into any detailed discussion of these interpretations of the observed facts.

SPECTROPHOTOMETRIC DETECTION OF TRICRESYL PHOSPHATE (TCP)  
IN FOODSTUFFS

S. K. KRISHNAN, V. V. S. MURTI AND T. R. SESHADRI

(From the Department of Chemistry, Delhi University, Delhi)

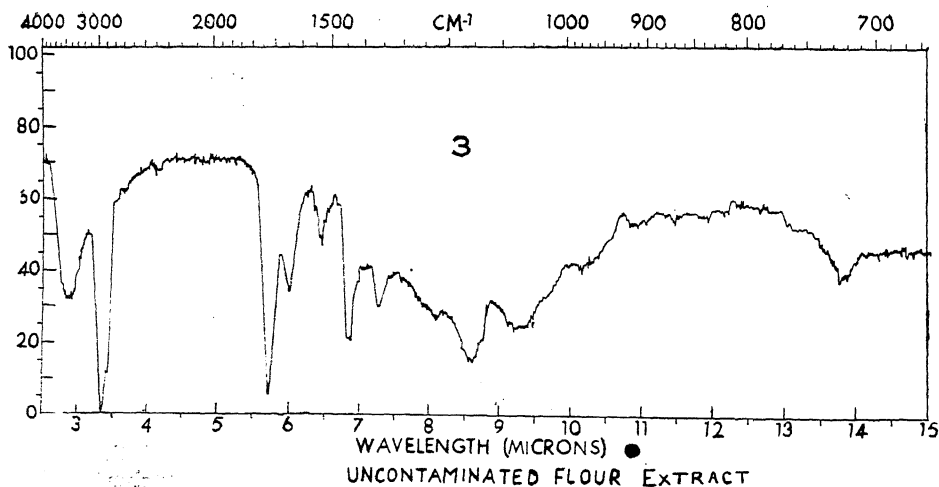
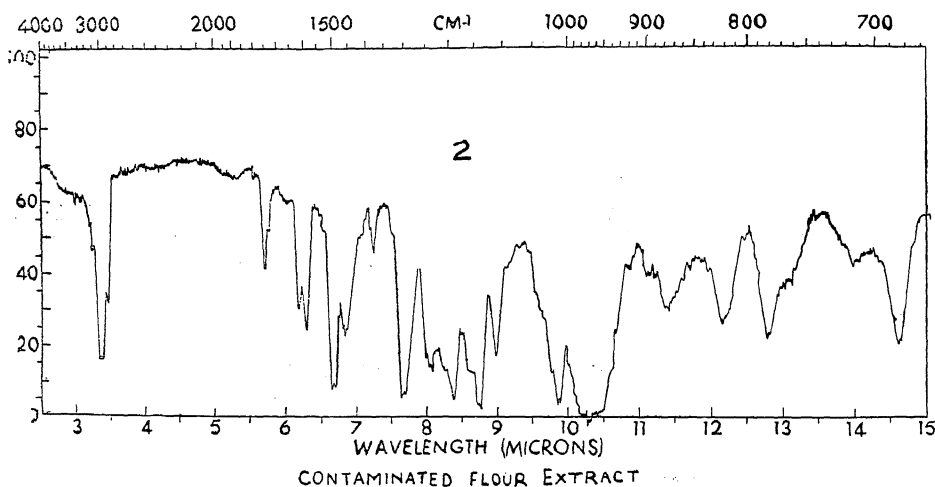
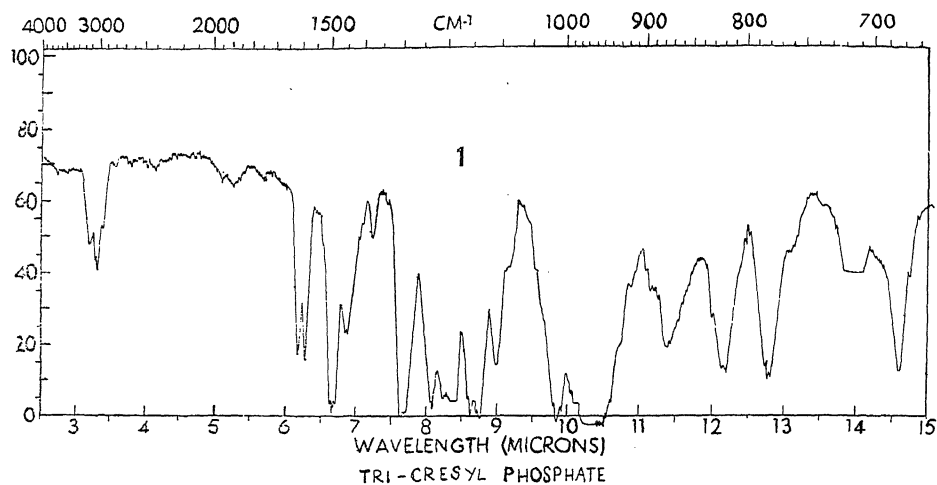
INCREASING use of insecticides in pest control and inadequate methods of their storage and transport have frequently resulted in serious contamination of foodstuffs. This is responsible for an alarming increase in cases of food poisoning and is causing considerable anxiety. Recently, severe cases of illness and even death due to food poisoning have been reported from different parts of India. Various kinds of food materials were stated to have been contaminated, viz., wheat flour, milk-powder, edible oils, etc. Though the actual contaminant has not been definitely identified in most cases, it was suspected that certain organic phosphorus compounds like 'folidol' and 'tricresyl phosphate' were involved in specific cases. For these reasons, the development of efficient and rapid methods for the detection and estimation of pesticide residues in foods has assumed considerable importance.<sup>1-3</sup> In general, the procedure consists of, (i) extraction of the contaminant from the foodstuff with an organic solvent, e.g., benzene, chloroform and petroleum ether, (ii) concentration of the extract and removal of interfering substances by partition between solvents and/or chromatography on adsorbents like alumina, celite or florisil, and (iii) detection and determination of the insecticide by physical, chemical, bioassay or microbiological<sup>4</sup> methods. Vapour phase chromatography has also been used<sup>5</sup> for detection purposes.

In April 1962, a serious outbreak of a paralytic disease occurred in the Malda District of West Bengal. The source was traced to wheat flour which was supplied to the local inhabitants. Chaudhuri *et al.*<sup>6</sup> after a detailed study of the clinical symptoms of the disease surmised that the contaminant was probably tricresyl phosphate (TCP). This was confirmed by a chemical examination of the flour samples according to the method of Collins.<sup>7</sup> An oily extract of the flour was hydrolysed with alkali, the hydrolysate acidified and the cresols steam-distilled. The steam distillate was treated with diazotized *p*-nitroaniline and the azo-dye formed estimated colorimetrically. The results were also verified by a determination of the phosphorus content of the extracts. The contamination was reported to be quite heavy, about 15%.

When our attention was drawn to this problem, we felt that a simpler and a more definite method of identifying TCP would be by the use of infra-red spectra.<sup>8,9</sup> Therefore, the flour samples (ca. 100 g.) were extracted with boiling light petroleum (b.p. 60–80° C.) (2 × 250 ml., 2 hrs. each time), the extract was filtered and the solvent removed. The infra-red spectrum of the oily residue was taken (thin film) (0.2 mm. cells) on Perkin-Elmer "Infracord", Model 137 Infra-red Spectrometer. For comparison, similar spectra of authentic TCP (Fig. 1) and of an extract of a sample of uncontaminated flour (Fig. 3) were also taken. Of the fourteen samples examined, two were contaminated with TCP to a small extent. A flour sample, kindly provided by Prof. R. N. Chakravarti, was also examined (Fig. 2); there was no doubt that it was contaminated heavily with TCP.

In order to assess the applicability of the method for the detection of TCP in edible oils, infra-red spectra of sesame oil (pure) as well as those of samples containing known amounts of TCP were taken (thin films). Under the conditions of the experiment, TCP could be detected in about 5% concentration; there is no interference by the fatty portion in the detection of TCP either in wheat flour or in sesame oil. However, when the TCP was present in smaller amounts the detection was not definite; in these cases concentration could be effected by chromatography as explained later.

Attempts were also made to use ultra-violet absorption for a quantitative determination of TCP in flour samples and edible oils. Preliminary studies showed that TCP has a characteristic peak at 235 m $\mu$  in hexane solution and this absorption could be used. A standard curve was drawn by plotting optical densities at 265 m $\mu$  against concentrations of TCP in purified hexane. The hexane, which is ordinarily available in the market contains considerable amount of impurities absorbing in the ultra-violet. Purification is best done by refluxing with one-third its volume of concentrated sulphuric acid (2 × 4 hrs.), followed by refluxing with a saturated solution of potassium permanganate in 10% sulphuric acid (4 hrs.).



FIGS. 1-3



The hexane layer is then separated and distilled. A source of error in the quantitative determination of TCP from optical density measurements at  $265\text{ m}\mu$  is the influence of the fatty material. Sesame oil has a low maximum at  $286\text{ m}\mu$  and its absorption at  $265\text{ m}\mu$  is relatively small. On the other hand the absorption of the flour extracts has no characteristic maximum and the absorption at  $265\text{ m}\mu$  is not negligible; for this reason the estimates of the amount of TCP are likely to be higher. Hence it is desirable to make use of chromatography to separate TCP from the fatty portion in the extractives, and this would also, incidentally, concentrate the former. Abdallah and Landheer<sup>5</sup> reported that in insect extracts, the insecticides (DDT, Parathion and Lindane) could be separated from the fat components by chromatography on celite. We studied this method in the present case. In a typical experiment, chromatography on a celite column ( $58 \times 1\frac{1}{2}\text{ cm.}$ ) was carried out, by placing contaminated sesame oil (containing 5% TCP) on top of the column. Elution was done with purified hexane; the eluate was collected in 5 ml. fractions and the optical density of each fraction measured at  $265\text{ m}\mu$  and  $286\text{ m}\mu$ , using a Beckmann Model DU Spectrophotometer. The fatty material was eluted first, before the TCP. Similar results were obtained with contaminated wheat flour. The method appears to be a convenient and useful one for the quantitative concentration of TCP when present in small amounts.

In recent years, a considerable number of organophosphorus insecticides have been developed. In addition to having high insecticidal action, they also possess considerable mammalian toxicity.<sup>10</sup> Attempts are being made to

develop phosphorus compounds with low toxicity to mammals and some success has been claimed.<sup>11</sup> The problem of contamination of foodstuffs by toxic residues, however, is still very real, and there is need for a close watch on such possibilities to minimise suffering and anxiety. The procedure described above for qualitative detection and quantitative determination of TCP is capable of adaptation to other organo-phosphorus compounds in general. We believe that refinements are certainly possible to extend its applications and sensitivity.

Our grateful thanks are due to Dr. N. S. Aggarwal of the Ministry of Food and Agriculture, Government of India, and Prof. R. N. Chakravarti of the School of Tropical Medicine, Calcutta, for the flour samples.

1. Chilwell, E. D. and Hartley, G. S., *Analyst*, 1961, **86**, 148.
2. Laws, E. Q. and Webley, D. J., *Anal.*, 1961, **86**, 249.
3. Schechter, M. S. and Hornstein, I., in *Advances in Pest Control Research*, Ed. R. L. Metcalf, Interscience Publishers, Inc., New York, 1957, **1**, 353.
4. Tew, R. P. and Sillibourne, J. M., *J. Sci. Food and Agri.*, 1961, **12**, 618.
5. Abdallah, M. D. and Landheer, C. A., *J. Chromat.*, 1962, **9**, 245.
6. Chaudhuri, R. N. Chakravarti, R. N., Ghosh, S. M., Sarkar, J. K. and Adhya, R. N., *Sci. and Cult.*, 1962, **28**, 334.
7. Collins, E., *Analyst*, 1945, **70**, 326.
8. Bellamy, L. J. and Beecher, L., *J. Chem. Soc.*, 1952, pp. 475, 1701.
9. McCauley, D. E. and Cook, J. W., in *Proc. Symp. Instrum. Methods for Anal. Food Additives*, Interscience Publishers, Inc., New York, 1961, p. 137.
10. Fukuto, T. R., in *Advances in Pest Control Research*, Ed. R. L. Metcalf, Interscience Publishers, Inc., New York, 1957, **1**, 147.
11. Sherlock, E., *Chemistry and Industry*, 1962, p. 715.

## MICROBIOLOGY AND WORLD FOOD SUPPLIES

AT the eighth International Congress for Microbiology, held in Montreal during Aug., 1962, great concern was expressed at the widening gap existing between the global rates of increase of population and of food supply. The Congress considered how best microbiology might help towards a future need to increase world food production.

One attack on this problem is to improve the fertility of soils, in which connection the following would be helpful: (a) A study of thermophilic and mesophilic micro-organisms capable of more rapidly transforming such non-food wastes as sawdust, straw, weeds, leaves, sludge, etc., into suitable organic matter of manurial value, (b) Research on the effect of herbicides,

fungicides and other chemicals on micro-organisms, in order to attempt to control soil population. (c) Further studies on the effectiveness and wider distribution of *Azotobacter*, *Rhizobium* and other micro-organisms capable of fixing atmosphere nitrogen.

Another field of investigation is to find sources of food additional to orthodox agricultural production. It should be realized that micro-organisms should be capable of supplying some of these; for micro-organisms are able to produce edible protein, fat or carbohydrate, and vitamins, from materials entirely inaccessible to human or mammalian digestion, yet do not require agriculturally useful land,

## CONSIDERATIONS ON THE AFRICAN ORIGIN OF *ELEUSINE* *CORACANA* (L.) GAERTN.

K. L. MEHRA\*

*Royal Botanical Gardens, Kew, Richmond, Surrey, U.K.*

THE agricultural connections between India and Africa are so obvious that numerous authors<sup>1-3</sup> have referred to them. It is reasonably certain that a number of cultivated plants in Africa have come from India, but most of these introductions have probably been within the Christian era. Recently, however, Anderson<sup>1</sup> has called attention to the fact that there is a possibility of a much earlier movement of primitive agricultural products from Africa through Ethiopia and Yemen and up the seaward edge of the Arabian peninsula and into Southern India. The lack of realisation of an earlier migration of crop plants from Africa to India was perhaps due to the fact that firstly, all such plants bear Sanskrit names; secondly all of them are crops of such minor importance as not to have merited attention had anything as sophisticated as the late Stone Age domesticates been available, and lastly all of them were unknown in ancient Egypt, or appear very late in the record. During the course of the present investigation preliminary experimental evidence has been gathered together to suggest that perhaps the Ragi Millet *Eleusine coracana* (L.) Gaertn. is one of the cultivated plants which migrated at an early date from Africa to India.

De Candolle<sup>4</sup> indicated that *E. coracana* probably originated in India since firstly, the ancient monuments in Egypt bear no trace of its cultivation in the earlier times and secondly the earlier Graeco-Roman authors, who knew that country so well do not speak of this crop. Burkill<sup>5</sup> suggested that *E. coracana* is a cultigen of the wild species *E. indica* (L.) Gaertn., and that its early selection by man appears to have taken place in India since firstly, it has long been cultivated there; secondly it has Sanskrit name, i.e., *Rajika* or Ragi; thirdly it was there probably at the time when the Aryans arrived in India and lastly its decrease in Africa towards the west would also suggest that perhaps it has crossed from east to the west. Also, Werth<sup>6</sup> was of the opinion that *E. coracana* originated in India from where it spread through Arabia, Abyssinia, to the rest of Africa. However, Vavilov<sup>3</sup> proposed that *E. coracana* originated in Abyssinia, while Chandola<sup>7</sup> has expressed the opinion that perhaps the millet

originated in India and Africa. Furthermore, it was pointed out<sup>8</sup> that India and Africa have several features in common with respect to the genus *Eleusine* especially the presence of a similar number of dominant genes; similar extent of diversity of species; similar number of wild species and lastly the similar type of cytological behaviour of the materials so far investigated. These facts considered together would, thus, complicate the problem of the migration of *E. coracana* from India to Africa or *vice versa*.

Cytological studies conducted during the course of the present investigation have revealed the presence of a somatic chromosome complement of  $2n=18$  and 36 for *E. indica* and  $2n=36$  for *E. coracana*. Also, a regular formation of 18 bivalents was observed during meiosis in the microsporocytes in *E. coracana* and in the tetraploid *E. indica*. However, it may be pointed out that the tetraploid taxon of *E. indica* has recently been assigned<sup>9</sup> a separate specific epithet *E. africana* Kennedy O'Bryne on account of this cytological and certain morphological differences from the diploid form. The diploid taxon has, however, been retained within *E. indica*. Regular bivalent formation during meiosis, the presence of duplicate factors and polymeric factors in *E. coracana* would seem to suggest<sup>8</sup> that perhaps it is an allotetraploid.

Morphological analysis<sup>9,10</sup> of *Eleusine* species has revealed the presence of four distinct taxa, i.e., the wild types (*E. indica*:  $2n=18$  and *E. africana*:  $2n=36$ ) and cultivated types (*E. coracana*:  $2n=36$ ; African Highland type and Afro-Asiatic type). Furthermore, comparative taxonomical analysis of *E. indica* and *E. africana* revealed that the differences between these two species are mainly in size and proportions, i.e., in the widths of the rachis and stem and in the lengths of the spikelets, glumes and lemmas. These are the types of differences which one would often expect to find between closely related diploid and tetraploid taxa. Presuming that *E. indica* is perhaps one of the two putative parents of *E. africana*, the taxonomical description of the other putative parent has been worked out<sup>10</sup> and the herbarium material is being studied to find out the taxon with which it shall conform.

Amongst the cultivated types, the African Highland type differs from the Afro-Asiatic

\* Present Address: Botanist, Central Potato Research Institute, Simla-1, India.

type because of its longer lemmas, glumes and spikelets. Also, the grains are enclosed inside the glumes in case of the African Highland type, whereas these are exposed in Afro-Asiatic type. Furthermore, the African Highland type resembles *E. africana* because of the presence of long lemmas, glumes and spikelets, whereas on the contrary the Afro-Asiatic type resembles *E. indica* because of its short lemmas, glumes and spikelets. It has, however, been proposed<sup>10</sup> that *E. africana* originated as a result of hybridization between *E. indica* and a closely related taxon followed by chromosome doubling. It may also be pointed out that the morphological differences between African Highland type and *E. africana* are slight and these are shattering and non-shattering spikelets and plump and non-plump grains. One normally expects to find such differences between closely related wild and cultivated taxa. Furthermore, it has been shown<sup>11</sup> that in a farmer's field in Uganda the cultivated and wild types (*E. africana*) cross with each other and produce fertile hybrids. There is, thus, a good reason to believe, therefore, that the cultivated African Highland type might have originated from *E. africana* by selection at an early date for a large grain type. In fact, Anderson<sup>1</sup> frequently saw a semicultivated variety of *E. indica* in Ethiopia, which may as well be *E. africana* or *E. coracana* (African Highland type) or their hybrid derivatives. These semi-cultivated types seem to have been developed for their long wiry culms, which are used in making the expertly fashioned native sieves. The sieve itself is knit from these stems, producing a fine tough sieve of remarkably even mesh. There are no reports of such sieves from other parts of the world and, if these are unique to Africa, then it has been argued<sup>1</sup> that the presence of a specialized use for this grass in Ethiopia and of a domesticated or semi-domesticated robust strain developed there for this purpose increases the likelihood that *E. coracana* originated in Ethiopia, from where it migrated to India during the pre-Aryan times.

During the course of the present investigation more than 200 herbarium specimens of *E. indica* and *E. coracana* collected from India, Pakistan, Nepal and Sikkim have been studied and none of them conform to *E. africana* or *E. coracana* (African Highland type). Most of these plants belong to either *E. indica* ( $2n=18$ ) or *E. coracana* (Afro-Asiatic type:  $2n=36$ ). It would seem to suggest that perhaps *E. africana* and the cultivated African Highland type are not present in India. It is proposed that the naked grain Afro-Asiatic type common in India originated from the African Highland type

through selection for a small glumed type with exposed grains. Also, the genetic mechanism to produce such a reduction in the size of the glumes has already been suggested.<sup>10,11</sup> In fact, the hybridizing populations<sup>10</sup> of *E. africana* and *E. coracana* (African Highland type) in the farmer's field in Uganda produced amongst their segregates a few plants which resembled the Afro-Asiatic type. The evidence indicated as above seems to suggest that firstly, *E. africana* the progenitor of the African Highland type, originated from *E. indica* through hybridization with a closely related taxon followed by chromosome doubling in Africa and secondly the cultivated Afro-Asiatic type common in India was developed from the African Highland type in Ethiopia.

In conclusion, it can be said that there is good reason to believe that *E. coracana* is African in origin instead of Indian as proposed by earlier workers.<sup>4-6</sup> The present paper is an attempt to further document the possibilities of an earlier migration of crop plants from Africa to India by way of Sabaeen Lane on the basis of whatever little the author has been able to present. Nevertheless, it is hoped that such a possibility shall become more convincing when supported with data on other such little known crops from Africa.

The author wishes to express his gratitude to Dr. Edgar Anderson of Missouri Botanical Gardens, Saint Louis, U.S.A., for constant encouragement and interest during the present investigation. Thanks are also due to the Director, Kew Gardens, U.K., for the facilities to work and to the British Council for the grant of a post-doctoral fellowship to study the herbarium material at Kew.

1. Anderson, E., *The Evolution of Domestication in Evolution after Darwin*, Univ. Chicago Press, U.S.A., 1950, 2, 67.
2. Murdock, G. P., *Africa*, McGraw-Hill Book Co., New York, U.S.A., 1959.
3. Vavilov, N. I., *The Origin, Variation, Immunity and Breeding of Cultivated Plants*, The Ronald Press Co., New York, U.S.A., 1951.
4. De Candolle, A., *Origin of Cultivated Plants*, Kegan Paul, Trench & Co., London, 1886.
5. Burkill, I. H., *A Dictionary of Economic Products of the Malay Peninsula*, Crown Agents for the Colonies, London, 1935.
6. Werth, E., *Angew. Bot.*, 1937 19, 42.
7. Chandola, R. P., "Cytogenetics of milllets," *Cytologia*, 1959, 24, 115.
8. Krishnaswamy, N., "Origin and Distribution of milllets," *Indian J. Genet.*, 1951, 11, 67.
9. Kennedy O'Byrne, J., "Notes on African grasses," *Kew Bull.*, 1957 11, 65.
10. Mehra, K. L., "Differentiation of the cultivated and wild *Eleusine* species," *Phyton* (in press), 1963.
11. —, "Natural hybridization between *Eleusine coracana* and *E. africana* in Uganda," *J. Indian bot. Soc.*, 1962, 41, 530.

## LETTERS TO THE EDITOR

## MICROWAVE CRYSTALS AS THERMOMETERS IN LOW TEMPERATURE RANGE

We have taken the d.c. voltage current characteristics of point-contact microwave diodes like 1N21A, 1N23, of point-contact diodes 1N34, 1N38 and of some *p-n* junction diodes at room and liquid-air temperatures. It has been found that whereas the forward resistance of non-microwave diodes becomes zero at liquid-air temperatures and above, the forward resistance of microwave diodes decreases appreciably with decrease of temperature but never becomes zero.

Figure 1 depicts the V-I characteristics of a 1N21A microwave diode.

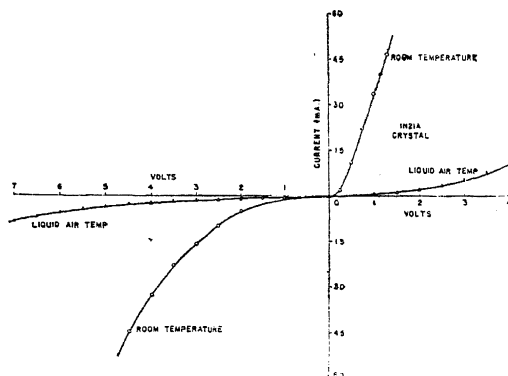


FIG. 1

On the basis of the above findings, the microwave diodes can well work as temperature indicators in the low temperature range. The forward resistance would decrease continuously as temperature decreases. Of all the microwave diodes tried, 1N21A type was found to have the best V-I characteristics for the purpose of temperature measurement. Experimentally, as a convenient method of measuring temperatures, 50-cycle a.c. of low enough voltage ( $\approx 2$  volts) was rectified. The d.c. output (both in the form of voltage and current) was found to be very much reproducible as the microwave crystals were repeatedly dipped in liquid air.

Attempts are being made to extend the temperature measuring ability of the microwave diodes to liquid-helium temperature range.

Electronics Division, K. D. KUNDRA.  
National Physical Lab., R. PARSHAD.  
New Delhi-12, May 21, 1963.

## OXINE DERIVATIVES

EDGERTON AND BURCKHALTER<sup>1</sup> prepared a series of oxine derivatives with alkyl and aryl groups at 5 positions but found them possessing less amœbicidal action than the standard drugs. The popular use of antibiotics in the cure of amœbiasis presents an additional problem of developing infection due to the possible alteration of the normal internal flora and to study the suitability of oxine derivatives for this condition, several alkoxymethyl oxine derivatives have now been prepared.

Oxine was subjected to chloromethylation according to the procedure of Burckhalter and Leib<sup>2</sup> and the resulting 5-chloromethyloxine on boiling with aliphatic alcohols was smoothly converted into 5-alkoxymethyl oxine. These derivatives in turn were subjected to Mannich reaction using morpholine/piperidine/diethanolamine individually and 0.1 mole of paraformaldehyde. Table I gives the melting points of the derivatives reported in this communication. 5-piperidinomethyl and 7-piperidinomethyl oxines on boiling with glacial acetic acid and hexamine<sup>3</sup> yielded respectively 5 and 7 aldehydes of 8-hydroxy quinoline as characterised by the formation of 2:4-dinitrophenyl hydrazones.

7-piperidinomethyl oxine revealed a pronounced drop in the blood pressure when injected intravenously on an anæsthetised dog. Satisfactory analytical values have been obtained for compounds mentioned in this communication.

TABLE I

Name of the compound	M.P.
5-Methoxymethyl oxine	79-80°
5-( <i>n</i> ) Propyloxymethyl oxine	76-77°
5-Methoxymethyl-7-piperidinomethyl oxine	160°
5-Methoxymethyl-7-morpholinomethyl oxine	157° (turns brown at 150°)
5-Methoxymethyl-7-diethanolaminomethyl oxine	188-90° (turns brown at 180°)
5-( <i>n</i> ) Propyloxymethyl-7-piperidinomethyl oxine	141-42°
5-( <i>n</i> ) Propyloxymethyl-7 morpholinomethyl oxine	135-37°
5-( <i>n</i> ) Propyloxymethyl-7-diethanolaminomethyl oxine	153-56°
Oxine-5-aldehyde	296-97° ( <i>d</i> )
Oxine-7-aldehyde	288-90° ( <i>d</i> )

The author thanks Dr. J. N. Tayal for his interest and the Director, D.R.L.(S.), Kanpur, for providing facilities. Thanks are also due to Messrs. A. K. Ghosh and O. P. Srivastava for the initial screening of one of the compounds.

Defence Science Lab., B. VENKATARAMANI,  
Metcalf House, Delhi-6,  
March 5, 1963.

1. Burchkalater, J. H. and Edgerton, W. H., *J. Am. Chem. Soc.*, 1951, **73**, 4837.
2. — and Leib, R. L., *J. Org. Chem.*, 1961, **26**, 4078.
3. Dare, P., Verlicchi, L. and Setnikar, L., *Ibid.*, 1960, **25**, 1097.

### VINYL POLYMERISATION INITIATED BY COBALTIC IONS

In recent years considerable attention has been paid to the kinetics of oxidation and polymerisation reactions initiated by the higher valency states of rare-earth and transition metal ions.<sup>1,2</sup> Studies on the oxidation of organic as well as inorganic substrates by cobaltic ions have been reported.<sup>3-5</sup> Substrates such as methanol,<sup>3</sup> formaldehyde,<sup>4</sup> olefins,<sup>5</sup> tertiary alcohols<sup>6</sup> and ions such as  $V^{IV}$  and  $Cr^{III}$  have been oxidised. We have carried out investigations on the initiation of vinyl polymerisation of the monomers methyl methacrylate, methyl acrylate, acrylonitrile and acrylamide by cobaltic ions in aqueous solution. Polymerisation initiated by cobaltic ions proceeds rapidly even at as low a temperature range as 10–20°C., in the three acid media, sulphuric, nitric and perchloric acids.

The cobaltic stock solutions have been prepared by anodic oxidation of the cobaltous salt in the corresponding acid. Cobaltic ion concentrations were estimated colorimetrically or potentiometrically. Water double distilled and deionised by passage through mixed bed 'Biodeminolit' resin was used throughout.

It has been found that under controlled conditions of acidity (0.5 to 1.5 M.) and ionic strength (1 to 2 M.) water oxidation by the cobaltic ions was minimum in perchlorate and nitrate media. Rates of monomer disappearance were independent of initial cobaltic ion concentration in all cases except those in sulphate media where they were proportional to  $[Co^{3+}]$ ,<sup>7</sup> and in the case of acrylamide initiated by cobaltic perchlorate where they varied as  $[Co^{3+}]$ .<sup>8</sup> Rates of monomer disappearance were proportional to 3/2 powers of monomer concentration as well as square of the monomer concentration, the latter being

the case where the rates were independent of initial cobaltic ion concentration (Fig. 1, A, B).

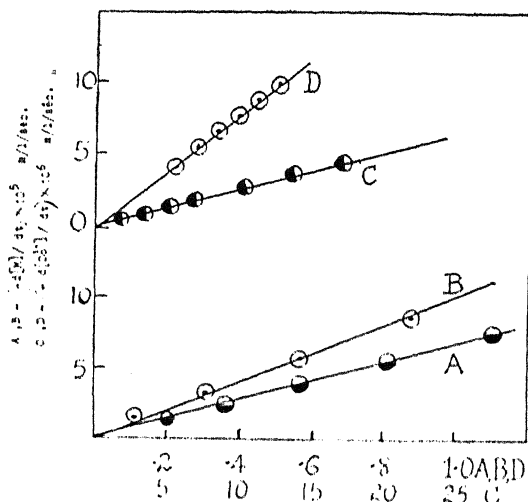


FIG. 1. A.  $[M]^2 (m/l)^2$  Acrylonitrile, Cobaltic Perchlorate, 15°C. B.  $[M]^{1.5} (m/l)^{1.5} \times 10$  Acrylamide, Cobaltic Perchlorate, 15°C. C.  $[Co^{3+}] \times 10^3 m/l$  Methylmethacrylate, Cobaltic Nitrate, 20°C. D.  $[M]m/l$  Methyl Acrylate, Cobaltic Nitrate, 15°C.

Rates of monomer disappearance were unaffected by changes in acid concentration in nitrate media, but were inversely proportional to  $[H^+]$  in sulphate and perchlorate media. In all the three media the rates increased with ionic strength. The viscometric chain lengths of the polymers formed were proportional to the initial monomer concentrations and varied inversely as the initial cobaltic ion concentration where the monomer order of the reaction was 2. Rates of cobaltic ion disappearance were proportional to both the initial monomer and cobaltic ion concentrations (Fig. 1, C, D). These rates varied inversely as  $[H^+]$  and directly as the ionic strength. The reaction is free radical in nature and a tentative mechanism based on electron transfer from vinyl monomer to cobaltic species producing a radical ion of the type  $II_2C^{\cdot+} - C^{\cdot-}H - X$  as well as termination of growing chains by cobaltic species has been postulated. Independence of rates of monomer disappearance on cobaltic ion concentrations would result only if termination is also by cobaltic species. This would also result in a monomer order of two. Where the termination reaction is one of mutual interaction of growing chains the rates would vary as 3/2 powers of monomer concentration and square root of the initial cobaltic ion concentration. Initially added cobaltous ions are without any

effect on any of the rates, indicating that the radical formation steps are not reversible. The influence of ionic strength on the various rates is related to its effect on the various equilibria involving cobaltic ions in the three media. Detailed experimental results with a full discussion will appear elsewhere.

Dept. of Physical Chemistry, K. JIJIE.  
University of Madras, V. MAHADEVAN.  
Madras-25, March 25, 1963.

1. Hargreaves and Sutcliffe, *Trans. Faraday Soc.*, 1955, **53**, 1105.
2. Saldick, *J. Polymer. Sci.*, 1956, **19**, 73.
3. Bawn and White, *J. Chem. Soc. (Lond.)*, 1951, pp. 331, 339, 343.
4. Rossiensky and Higginson, *Ibid.*, 1960, p. 31.
5. Hargreaves and Sutcliffe, *Trans. Faraday Soc.*, 1955, **51**, 786.
6. Bawn and Sharp, *J. Chem. Soc. (Lond.)*, 1957, pp. 1866, 2026.
7. Hoare and Waters, *Ibid.*, 1962, p. 965.
8. Sutcliffe and Weber, *Trans. Faraday Soc.*, 1958, **55**, 1892.

# A SIMPLE TIMER USING DEKATRON AND COLD CATHODE TRIGGER TUBES

IN many electrochemical processes, precise timing or measurement of time of small duration without any personal error is important. One of the important uses of such an instrument is in the accurate measurement of time in the thickness meters based on stripping technique.<sup>1</sup> This can also find use in the time-delay unit meant for switching the polarographic current at a predetermined phase in the life of the mercury drop wherein the polarographic current will be relatively free from the capacitative current and mainly diffusion controlled.<sup>2</sup>

## DEKATRON SCALER

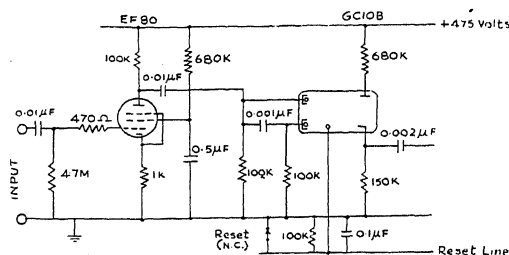


FIG.2 VALVE DRIVE CIRCUIT FOR DEKATRON

Note: All Resistances are 1W, 10%.

$$K = x \cdot 10^3 \Omega$$

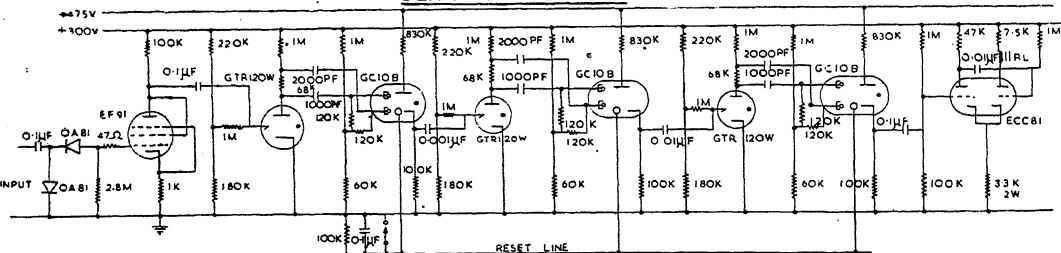
$$M = \times 10^6 \Omega$$

$$\mu F = \times 10^{-6} F$$

FIG. 2

In the present circuit, cold cathode trigger tubes have been employed to drive the dekatron tubes in preference to hard valves because of the simplicity of the circuitry, and also the low cost of the components associated with the former. The only disadvantage of the cold-cathode trigger tube is that they cannot be used at frequencies higher than 300 c./s. if employed for counting purposes. The limiting precision of the time measurement is of the order of 0.0033 seconds which corresponds to an input frequency of 300 c./s. which will be well within the requirements of many similar applications. By employing a hard valve drive circuit at the input stage, in place of the input cold cathode trigger tube, it is possible to extend the range to 3 kc./s. For the measurement of time, the output of an audio-oscillator whose frequency is within the range of 300 c./s. is fed to a pulse shaper circuit using two OA 81 diodes and then to a single stage amplifier.

## DEKATRON SCALER



NOTE 1) ALL RESISTANCES ARE 10%, 1 WATT, UNLESS OTHERWISE SPECIFIED.

- 2)  $K = X 10^3 \Omega$
- 3)  $M = X 10^6 \Omega$
- 4)  $\mu F = X 10^6 \text{ FARAD}$
- 5)  $P F = X 10^{12} \text{ FARAD}$
- 6)  $RL = \text{REGISTERING RELAY (I.T.I.)}$

FIG. 1

The output voltage will be sufficient to trigger the cold cathode trigger tube GTR 120 W. The trigger electrode is held at + 120 volts. The tube will fire when a positive pulse of the order + 20 volts is applied. The tube is brought to the normal quenched condition immediately after the breakdown because of the fall in the plate voltage much below the value for maintaining the discharge due to the heavy drop across the large resistance included in the plate circuit. A short pulse of short duration is produced to trigger the cold cathode dekatron tube GC 10 B. The cold cathode dekatron tube contains a central anode in the form of a disc surrounded by ten cathodes evenly spaced around the anode. Adjacent to every cathode is another electrode, ten of which are internally connected and called the first guide electrode  $G_1$ . Another set of guides adjacent to the first guide electrodes is called the second guide electrodes  $G_2$ . The first and second guide electrodes are held at + 18 volts with respect to earth potential; and a red glow will always rest on one of the electrodes.

TABLE I

Dekatron scaler	50 c./s. Time taken for 60 counts (Frequency $f_1$ )	100 c./s. Time taken for 70 counts (Frequency $f_2$ )	200 c./s. Time taken for 20 counts (Frequency $f_3$ )
A.E.E.T* D.S. 30A	1087 seconds	888 seconds	96 seconds
Reported Dekatron Scaler	1092 seconds	889 seconds	96.2 seconds
Accuracy	+0.46%	+0.11%	+0.2%

\* Manufactured by Atomic Energy Establishment, Trombay (India).

The negative pulse from the cold cathode trigger tube is applied to guide 1 through a 1000  $\mu\mu\text{F}$  condenser and to guide  $G_2$  through a 2000  $\mu\mu\text{F}$  and there is a small time-lag between the arrivals at  $G_1$  and  $G_2$ . For every incoming pulse, the glow is transferred to the next cathode through the guides  $G_1$ ,  $G_2$  and for every ten pulses received by the dekatron tube, one pulse is produced at the output cathode to trigger the next stage. Any amount of pulse division is possible by cascading the stages and is limited only by the input capacity of receiving of pulses of the first trigger tube which in turn is limited by the deionisation time of the gas of the cold cathode tubes. The output pulse

from the last dekatron tube triggers a cathode coupled mono-stable multivibrator which carries the coil of a registering mechanism in the plate circuit. The registering mechanism is once actuated for very 1000 pulses received at the input side.

With a view to extend the counting rate to 3 kc./s., a hard valve drive circuit for the first dekatron tube was incorporated in place of the first cold cathode trigger tube.

The authors thank Prof. K. S. G. Doss, Director, for his interest in the work.

Central Electrochemical Research Institute,  
Karaikudi (India),  
April 11, 1963.

S. B. R. SHENOY.  
U. H. NARAYANAN.  
K. SUNDARARAJAN.

1. Narayanan, U. H., Sundararajan, and K. Shenoy S. B. R. (communicated for publication).
2. — and Venkatachalam, K. R., *J. Electroanalytical Chem.*, 1963, 5, 158.

#### PHOTOLYTIC PREPARATION OF VANADYL SULPHATE FROM VANADIUM PENTOXIDE

PHOTOCHEMICAL reduction of vanadium (V) to vanadium (IV) state has been observed by Renz.<sup>1</sup> The present note describes an attempt made by us to prepare vanadium (IV) compounds from vanadium pentoxide by photolytic method.

When a suspension of vanadium pentoxide in 6 N sulphuric acid is exposed to sunlight with either formic acid or alcohol, vanadium pentoxide undergoes photoreduction and a blue solution is obtained. When the solution is evaporated at low temperature, deep blue crystals of hydrated vanadyl sulphate are obtained.

Vanadium content of the compound was estimated as  $\text{V}_2\text{O}_5$ . Vanadium (IV) content was estimated by titrating solutions of the weighed quantity of the substance in 6 N sulphuric acid against standard  $\text{KMnO}_4$ . Sulphate content was determined by barium sulphate method. The compound has been tested to be free from organic substances. Analysis of the compound shows that the compound isolated possesses the formula  $\text{VOSO}_4 \cdot 3 \text{H}_2\text{O}$ .

Vanadium: found 23.44%; calculated 23.5%.  
Sulphate: found 44.36%; calculated 44.24%.

The process of photochemical dissolution of vanadium pentoxide has been applied for the separation of vanadium from ferrovanadium ores,

The authors are grateful to Dr. D. Patnaik, Ravenshaw College, Cuttack, for his kind encouragement.

Department of Chemistry, B. SAHOO.  
M.P.C. College, Baripada, K. C. SATPATHY.  
Orissa, February 13, 1963. R. PARMAR.

1. Renz, C., *Helvetica Chem. Acta*, 1921, 4, 961.

### $\alpha$ -NITROSO- $\beta$ -NAPHTHOL AS AN INDICATOR IN THE MERCURIMETRIC DETERMINATION OF CHLORIDE AND BROMIDE IONS

$\alpha$ -NITROSO- $\beta$ -NAPHTHOL reacts in acidic medium with mercuric ions giving an intense red precipitate. The author made use of this fact in mercurimetric titrations of chloride and bromide ions. Many indicators<sup>1</sup> have been employed in mercurimetric methods for determining chloride and bromide ions of which diphenylcarbazone is most promising. However, the present method does not require blank titration as needed in the case of diphenylcarbazone because the indicator is very sensitive towards mercuric ions.

*Estimation of chloride and bromide ions.*—An aliquot portion of the standard solution of KCl or KBr was brought to pH 7 with sodium hydroxide (0.2 N). Then 2-4 drops of  $\alpha$ -nitroso- $\beta$ -naphthol (2% in EtOH) were added and titrated against mercuric nitrate (0.1 N) slowly with vigorous shaking till slight permanent reddish precipitate appeared. Care was taken during the addition of the last few drops. The results are summarised in Table I.

TABLE I

No.	Wt. of ion taken (g.)	Wt. of ion found (g.)
Estimation of chloride ion		
1	0.0396	0.0399
2	0.0564	0.0566
3	0.0753	0.0752
4	0.1025	0.1026
Estimation of bromide ion		
1	0.0861	0.0863
2	0.1235	0.1238
3	0.1722	0.1721
4	0.2153	0.2154

The above results show that  $\alpha$ -nitroso- $\beta$ -naphthol can be used as an indicator in the above estimations and the results obtained are of the same order of accuracy as in the case of diphenylcarbazone.<sup>2-3</sup>

This procedure may also be employed for the determination of non-halide mercuric ions by

adding an excess of standard chloride solution and back-titrating.

The author is thankful to Dr. S. Siddappa for his encouragement.

Department of Chemistry, S. V. PATIL.  
Karnatak University,  
Dharwar, February 11, 1963.

1. Kolthoff, I. M. and Stenger, V. A., *Volumetric Analysis II*, Interscience Publishers, Inc., New York, p. 334.
2. Roberts, I., *Ind. Eng. Chem. Anal. Ed.*, 1936, 8, 365.
3. McCleary, H. R., *Ibid.*, 1942, 14, 31.

### 2:3-DIHYDROXY-NAPHTHALENE-6-SULPHONIC ACID (SODIUM SALT) AS AN ANALYTICAL REAGENT FOR ZIRCONIUM

A NUMBER of dihydroxy-naphthalene-di-sulphonic acids<sup>4</sup> and their derivatives<sup>5-10</sup> have been used as analytical reagents. However, very little work has been done on dihydroxy-naphthalene-mono-sulphonic acids as analytical reagents. Sommer has reported the use of 2:3-Dihydroxy-naphthalene-6-sulphonic acid (sodium salt) for the detection of iron (III), uranium (VI), cerium (III), cerium (IV), titanium (IV) and molybdenum (VI).<sup>11</sup> Since this reagent is readily available because of its use as an intermediate in the production of azo-dyes, the present investigation deals with its further analytical applications. It has now been found that when an aqueous solution of its sodium salt is added to zirconium solution, a white gelatinous precipitate is formed which on ignition yields  $ZrO_2$ . Zirconium can in this way be determined between pH 1.0 and 3.0 and in quantities as low as 5.2 mg. Since titanium and uranium form soluble complexes with this reagent zirconium can be determined in their presence.

1% 2:3-Dihydroxy-naphthalene-6-sulphonic acid (sodium salt) (L. Light & Co.) was used. Metallic salts were of A.R. quality. Dilute hydrochloric acid and sodium hydroxide were used for pH adjustment and pH measurements were taken with a Beckman pH Meter model H 2, using a suitable glass electrode.

*Determination of zirconium with 2:3-Dihydroxy-naphthalene-6-sulphonic acid (sodium salt).*—To 50 ml. of zirconium oxychloride solution containing about 20 mg. of  $ZrO_2$ , 2-3 gm. of ammonium nitrate and 10 ml. of 1% aqueous solution of the reagent were slowly added with



constant stirring. The gelatinous white precipitate thus obtained was heated on a water-bath for about half an hour. After cooling and subsequent filtration through Whatman filter paper No. 42, and washing with water, the precipitate was dried and ignited to  $ZrO_2$ . The results obtained are given in Table I. The oxalate, sulphate, acetate, tartrate and citrate ions interfere in this estimation.

TABLE I

Wt. of $ZrO_2$ , taken (by oxine method), mg.	Wt. of $ZrO_2$ found, mg.
5.2	5.2
10.2	10.2
20.6	20.6
29.6	29.6
41.6	41.5

**Effect of pH on the Formation of the Zirconium Complex.**—The precipitation of the zirconium complex was complete between pH 1.0 and 3.0 (Table II).

TABLE II

Wt. of $ZrO_2$ taken	20.6 mg.						
Wt. of $ZrO_2$ found, mg.	2.8	19.4	20.6	20.6	20.6	18.8	17.2
pH	0.5	0.8	1.0	2.0	3.0	3.5	4.0

**Determination of Zirconium in presence of Titanium and Uranium.**—The reagent forms soluble coloured complexes with iron, titanium and uranium. The procedure for the determination of zirconium in presence of titanium and uranium is the same as for the determination of zirconium alone. The precipitate before ignition was thoroughly washed with 1% ammonium nitrate solution.

Zirconium could be estimated in presence of large quantities of titanium and uranium (Table III). Minute quantities of iron did not

TABLE III

Wt. of $ZrO_2$ taken, mg.	Wt. of $TiO_2$ added, mg.	Wt. of $U_3O_8$ added, mg.	Wt. of $ZrO_2$ found, mg.
20.6	16.4	18.0	20.6
20.6	32.8	36.0	20.6
20.6	41.0	45.0	20.6
18.2	41.0	45.0	18.2
18.2	49.2	54.0	18.2
18.2	82.0	90.0	18.2

interfere in this estimation, but the results were not quantitative in presence of larger quantities of iron. The presence of thorium and cerium (IV) interfered in the determination whereas lanthanum and yttrium, which

did not form any complex with the reagent, did not cause any interference.

2:3-Dihydroxy-naphthalene-6-sulphonic acid (sodium salt) has been used for the estimation of zirconium at pH 1.0 to 3.0. As the reagent forms soluble coloured complexes with titanium and uranium, the estimation of zirconium can be carried out in presence of large quantities of these.

The authors are grateful to Prof. T. R. Seshadri, F.R.S., for his keen interest and helpful discussions.

Department of Chemistry,  
University of Delhi,  
Delhi-6, May 15, 1963.

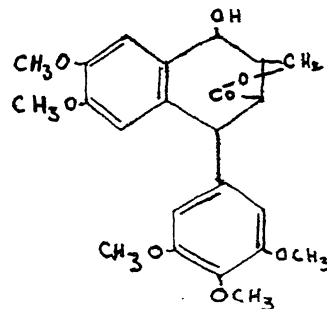
BRAHM DEV.  
B. D. JAIN.

1. Sommer, L., *Chem. Listy.*, 1958, 52, 1485.
2. Klinger, P., Stengel, E. and Wirtz, H., *Metall u. Erz.*, 1941, 38, 124; Sommer, L., *Acta Chim. Acad. Sci., Hung.*, 1959, 18, 121.
3. Mukherjee, A. K. and Dey, A. K., *J. Indian Chem. Soc.*, 1958, 35, 113.
4. Kuznetsov, V. I. and Basargin, N. N., *Zhur. analit. Khim.*, 1961, 16, 573.
5. Datta, S. K., *Z. anal. Chem.*, 1960, 173, 369.
6. Savvin, S. B. and Bogreev, V. V., *Zavodskaya Lab.*, 1960, 26, 412; Kuznetsov, V. I. and Savvin, S. B., *Radiokhimiya*, 1961, 3, 79.
7. Matsuyama, H., Hara, T. and Koyama, K., *J. Chem. Soc. Japan, Pure Chem. Sect.*, 1958, 79(5), 958.
8. Takhashi, T. and Miyake, S., *Talanta*, 1959, 3, 155.
9. Holcomb, H. P. and Voe, J. H., *Anal. Chim. Acta*, 1960, 32, 612.
10. Nemodruk, A. A., Novikov, Y. P., Lukin, A. M. and Kalinina, I. D., *Zhur. Analit. Khim.*, 1961, 16, 180.
11. Sommer, L., *Z. Anal. Chem.*, 1962, 187, 263.

## LIGNANS

### Part III: Synthesis of a Tetralone related to Sikkimotoxin

The phenyltetralin group of lignans have in recent years gained much importance. Some of the members of this group are cancer inhibitors.<sup>1</sup> Chatterjee isolated the lignan—sikkimotoxin from *Podophyllum sikkimensis*<sup>2</sup> and assigned to it the following structure on degradational evidences.



Sikkimotoxin has four asymmetric centres and hence can exist theoretically in sixteen optically active forms and eight racemates. Only one of the sixteen possible optical isomers—isosikkimotoxin has been obtained from picropodophyllin,<sup>3</sup> synthesised recently.<sup>4</sup> The present communication describes the synthesis of a 3-carboxy-4 (3', 4', 5'-trimethoxyphenyl)-6, 7-dimethoxy-1-tetralone, an important intermediate for the synthesis of sikkimotoxin.

Trimethyl gallic acid was condensed with veratrol in polyphosphoric acid.<sup>5</sup> The pentamethoxybenzophenone thus obtained was further condensed with diethylsuccinate in sodium methoxide. The two isomeric itaconic acids (A) and (B) thus obtained were separated by fractional crystallisation. (A) had a melting point 195° (Found: C, 61.2%; H, 5.7%.  $C_{22}H_{24}O_9$  requires: C, 61.1%; H, 5.5%) and (B) had a melting point 197°. (Found: C, 61.2%; H, 5.9%.  $C_{22}H_{24}O_9$  requires: C, 61.1%; H, 5.5%). Their mixed melting point was depressed by 10°.

On reduction with hydrogen over palladised charcoal the itaconic acid (A), m.p. 195°, gave the benzhydrylsuccinic acid (C), m.p. 123°. (Found: C, 60.6%; H, 5.9%.  $C_{22}H_{24}O_9$  requires: C, 60.8%; H, 6.0%). On reduction in a similar manner the itaconic acid (B), m.p. 197°, gave an isomeric benzhydrylsuccinic acid (D), m.p. 180°. (Found: C, 60.6%; H, 6.3%.  $C_{22}H_{26}O_9$  requires: C, 60.8%; H, 6.0%). The u.v. spectra of the two benzhydrylsuccinic acids were identical.

Cyclisation of the benzhydrylsuccinic acid (D), m.p. 180°, with polyphosphoric acid gave a ketone, m.p. 241°. (Found: C, 63.5%; H, 5.8%.  $C_{25}H_{24}O_8$  requires: C, 63.4%; H, 5.7%); 2: 4-dinitrophenylhydrazone, m.p. 272°. (Found: N 9.2%.  $C_{25}H_{23}N_4O_{11}$  requires: N, 9.4%).  $\lambda_{max}^{alc.}$  at 314 m $\mu$  (log  $\epsilon$ , 4.02) in the u.v. spectrum of the ketone showed the presence of a carbonyl group in conjugation with the benzene ring. The absorption band at 1650 cm<sup>-1</sup> in its i.r. spectrum indicated the presence of a six-membered cyclic ketonic system fused with an aromatic ring,<sup>4</sup> thus showing that the ketone was a tetralone and not a hydrindone.

The tetralonecarboxylic acid m.p. 241° was esterified with ethyl alcohol and sulphuric acid and the ester crystallised from alcohol, m.p. 145° (Found: C, 64.7%; H, 6.5%.  $C_{24}H_{26}O_8$  requires: C, 64.8%; H, 6.3%). The ester was condensed with ethyl formate in presence of sodium hydride. The hydroxymethylene compound thus obtained was crystallised from methanol, m.p. 157°. (Found: C, 62.0%; H, 6.2%.  $C_{25}H_{26}O_9$ .  $CH_3OH$  requires: C, 61.9%;

H, 6.3%). Crystallisation from ethyl acetate-petrol ether (40-60°) gave a compound m.p. 157°. (Found: C, 63.3%; H, 6.2%.  $C_{25}H_{28}O_9$  requires: C, 63.5%; H, 5.9%). Acetate m.p. 151°. (Found: C, 63.0%; H, 6.0%.  $C_{27}H_{30}O_{10}$  requires: C, 63.0%; H, 5.8%).  $\lambda_{max}^{alc.}$  at 354 m $\mu$ . (log  $\epsilon$ , 4.09) in the u.v. spectrum of the hydroxymethylene compound showed that the newly introduced double bond was in conjugation with the carbonyl group of the tetralone.

The above results indicate that the keto acid has an active methylene group confirming that the compound was a tetralone carboxylic acid and not an indanone acetic acid.

Synthesis of sikkimotoxin is in progress through the above tetralonecarboxylic acid. Detailed results including the stereochemistry of the tetralone and its precursors will be published elsewhere.

Department of Chemistry,  
Institute of Science,  
Bombay-1, January 20, 1962.

H. D. SHROFF.  
A. B. KULKARNI.

1. Greenspan, E. M., Leiter, J. and Shear, M. J., *J. Natl. Cancer Inst.*, 1950, **10**, 1295; Leiter, J., Downing, V., Hartwell, J. L. and Shear, M. J., *Ibid.*, 1950, **10**, 1273 (*Chem. Abstracts*, 1951, **45**, 2575).
2. Chatterjee, R. and Datta, D. K., *Indian J. Physiol.*, 1950, **4**, 61 (*Chem. Abstracts*, 1951, **45**, 7567). Chatterjee, R., *Econ. Botany*, 1952, **6**, 342 (*Chem. Abstracts*, 1953, **47**, 705).
3. Chatterjee, R. *Private Communication to J. L. Hartwell*.
4. Gensler, W. J., Samour, C. M., Wang, S. Y. and Johnson, F., *J. Am. Chem. Soc.*, 1960, **82**, 1714.
5. Kostanecki and Tambor, *Ber.*, 1906, **39**, 4027; Ayres, D. C. and Denney, R. C., *J. Chem. Soc.*, 1961, 4506; Diwadkar, A. B., Shroff, H. D. and Kulkarni, A. B. (Under publication).

### FLAVONOIDS OF THE FLOWERS OF *GUAZUMA TOMENTOSA* AND *DELONIX ELATA*

IN this note we report the results of our study of the flowers of *Guazuma tomentosa* Kunth., *Delonix elata* Gamble and *Allamanda cathartica* Linn., for their anthoxanthin pigments. In and around Pondicherry, *Tagetes erecta* is cultivated with heavy manuring for their large-sized flowers valued much for decoration. These flowers have been re-examined for any variation in the flavonoids bio-synthesized in the cultivated plants of this area.

*Guazuma tomentosa*.—Fresh flowers of *G. tomentosa*, which are golden yellow and found in large panicles, collected during September 1962 were extracted three times with 95% alcohol by cold maceration (lasting about 24 hr.)

and the combined extract concentrated *in vacuo* to remove almost all the solvent. The aqueous alcoholic concentrate was shaken with petroleum ether to remove fair amounts of waxy matter, and then with ether. The ether concentrate on paper chromatography and exposure to ammonia developed deep-yellow spots indicating the presence of flavonoids whose  $R_f$  values,<sup>1,2,3</sup> agreed with those of k  mpferol and quercetin. Separation of the two pigments was therefore effected by chromatography on large sheets of filter-paper as adopted earlier<sup>1</sup> and the identity of the pigments from the separated zones was confirmed by comparison with authentic specimens.

The aqueous alcoholic layer after ether extraction was kept in an ice chest for about a month when a brownish-yellow solid separated. This was twice crystallized from methanol-ether when yellow needles, m.p. 202–03°, were obtained. Its colour reactions and behaviour on paper chromatography indicated its identity to be k  mpferitrin. On acid hydrolysis, k  mpferol was obtained whose identity was established by its m.p.,  $R_f$  values on paper chromatography with different solvent systems and its acetate, m.p. 181–82°, and the sugar as rhamnose by paper chromatography,  $R_f$  value being 0.79 (phenol-water, lower layer).<sup>4</sup> The identity of k  mpferol and k  mpferitrin was also confirmed by comparison with authentic samples of the compounds. The total yield of the pigments was about 0.2%.

*Delonix elata* (Poinciana elata Linn.)—(White Gul Mohur).—Fresh petals of the flowers of *D. elata* which are ivory white to yellow collected during March 1962 were extracted and worked up for the flavonoid pigments in the usual manner.<sup>1</sup> The pale-yellow pigment isolated was found to be iso-quercitrin (yield 0.1%) whose identity was confirmed by mixed m.p. 220–22° and comparison with an authentic sample of the compound<sup>1</sup> and its acetate, m.p. 192–94°.

No flavonoid could be detected in the bark of *D. elata* (internally yellow) which on extraction with methanol yielded a basic nitrogen containing substance, m.p. 242–45° (yield, 0.3%).

*Allamanda cathartica*.—Fresh petals of the flowers of *A. cathartica* which are deep-yellow and very attractive were extracted with 95% alcohol in the cold, and the aqueous alcoholic concentrate shaken repeatedly with petroleum ether to remove all the carotenoid pigments and then with ether to get the free flavonols, which were identified as k  mpferol and quercetin. The aqueous alcoholic concentrate was left in an

ice chest for about a month and no solid separated. Hence, it was hydrolysed with 7% sulphuric acid, and quercetin and k  mpferol were identified in the mixture of aglucones. The sugar obtained by acid hydrolysis was only glucose, but the nature of the glycosides could not be established due to the very poor yield.

*Tagetes erecta*.—Fresh petals of large-sized flowers collected during December 1961 were extracted four times with 95% alcohol by cold maceration and the aqueous alcoholic concentrate studied systematically after partition with petroleum ether to remove all the carotenoid pigments<sup>5</sup> and ether in succession. From the ether extract, quercetageitin (yield, 0.4%) was obtained. The aqueous alcoholic layer after ether extraction was treated with excess of neutral lead acetate. The orange-red lead salt precipitate was suspended in alcohol and decomposed with hydrogen sulphide. The alcoholic filtrate containing the glycosides was concentrated *in vacuo* when some quercetageitrin<sup>6</sup> separated (yield, 0.2%). The mother liquor was kept in an ice chest for about three months when some yellow solid melting at 195–98° separated. It gave a strongly positive Pew's reaction. On paper chromatography, this was found to be a mixture and two spots were observed. Hence, it was acetylated using freshly distilled acetic anhydride and fused sodium acetate, and the crude acetate mixture crystallised from ethyl acetate-petroleum ether. The later fraction after two recrystallisations came out as colourless needles, m.p. 224–25° (which is close to the m.p. 226–27° of tagetiin acetate recorded by Morita<sup>7</sup>). On de-acetylation with methanolic hydrochloric acid, the acetyl derivative yielded quercetageitin.

The identity of tagetiin was also concluded from the  $R_f$  value 0.28 (butanol-acetic acid-water = 4 : 1 : 2), near to the value reported earlier,<sup>7</sup> and its colour reactions and dark green fluorescence in u.v.

It is interesting to note that the flowers of *G. tomentosa* belonging to the family Sterculaceae contain k  mpferol and its glycoside k  mpferitrin while those of *Theobroma cacao*<sup>8</sup> of the same family contain only quercetin with no k  mpferol. The flowers of *D. elata* contain only iso-quercitrin with little carotenoid pigments, while those of *D. regia*<sup>9</sup> contain quercetin along with small quantities of k  mpferol; very recently the carotenoid pigments of the different parts of the flowers of *D. regia* have been studied in detail.<sup>10</sup> The yellow to orange colour of the flowers of *A. cathartica* is mainly due to the carotenoid pigments. The

flowers of *T. erecta* had been earlier studied by Seshadri and co-workers<sup>6,11</sup> who isolated quercetagenin and quercetagitrin. However, Morita<sup>7</sup> later reported on the isolation of a 3-glycoside of quercetagenin named tagetiin and k  mpferitrin. It is interesting that we have now found the 3-glycoside of quercetagenin also present along with the 7-glycoside in the flowers of *T. erecta* cultivated in this area. The flowers of *T. erecta* have been recently reported<sup>12</sup> to be rich in helenien, a dipalmitic ester of the carotenoid lutein, which is beneficial in certain functioning of the retina.

We thank Prof. T. R. Seshadri for his kind interest in this work, Prof. M. Shimokoriyama and Prof. S. Hattori of Japan for the authentic specimen of k  mpferitrin from the leaves of *Celastrus orbiculatus* and Dr. S. G. Vengsarkar for encouragement. We are grateful to the Mother, Aurobindo Ashram, for permission to collect the flowers of *A. cathartica* for our work.

Medical College, S. SANKARA SUBRAMANIAN.  
Pondicherry, M. NARAYANA SWAMY.  
January 4, 1963.

1. Nair, A. G. R. and Subramanian, S. S., *Curr. Sci.*, 1962, **31**, 155, 504.
2. — and —, *J. Sci. and Ind. Res.*, 1962, **21 B**, 457.
3. —, — and Swamy, M. N., *Curr. Sci.*, 1962, **31**, 375.
4. Murthi, V. V. S., Raman, P. V., Seshadri, T. R. and Thakur, R. S., *J. Sci. and Ind. Res.*, 1962, **21 B**, 82.
5. Gillam, A. F. and E. L. Ridi, M. S., *Biochem. J.*, 1936, **30**, 1735.
6. Rao, P. S. and Seshadri, T. R., *Proc. Ind. Acad. Sci.*, 1941, **14 A**, 289.
7. Morita, N., *J. Pharm. Soc., Japan*, 1957, **77**, 31.
8. Griffiths, L., *Biochem. J.*, 1958, **70**, 120.
9. Pankajamani, K. S. and Seshadri, T. R., *J. Sci. and Ind. Res.*, 1955, **14 B**, 93.
10. Jungalwala, F. B. and Cama, H. R., *Biochem. J.*, 1962, **85**, 1.
11. Pankajamani, K. S. and Seshadri, T. R., *Proc. Ind. Acad. Sci.*, 1953, **37 A**, 718.
12. Tarpo, E. and Cucu, V., *Pharmazie*, 1961, **16**, 486.

### EVALUATION OF THE TOTAL UNSATURATION IN DEHYDRATED CASTOR OIL (D.C.O.)

Of the various methods available for the determination of unsaturation in dehydrated castor oil (D.C.O.), the Hanus number, using 400% excess reagent with a reaction time of 1 hour at 25° C., gives reproducible results and has been reported<sup>1</sup> to correspond fairly accurately to the total unsaturation introduced, irrespective of the arrangement of the bonds in the isolated

or conjugated position. While trying a wide range of catalysts<sup>2</sup> like  $H_2SO_4$ ,  $H_3PO_4$ ,  $NaHSO_4$ ,  $KHSO_4$ , china clay,  $P_2O_5$ ,  $CuSO_4$ ,  $Al_2(SO_4)_3$ , etc., for the dehydration of castor oil, it was observed<sup>3</sup> that the percentage dehydration calculated on the basis of Hanus number invariably corresponded to the difference in Iodine value between D.C.O. and castor oil, determined by Wijs' method, plus the percentage conjugation, for all the catalysts tried. If this could be represented by  $I + C$ , where,

$I$  = the difference in Iodine value between D.C.O. and castor oil, determined by Wijs' method, and using 0.1 g. of sample and a reaction time of 30 min. at 25° C. in the case of D.C.O.,

and  $C$  = the percentage conjugation, determined spectrophotometrically,

then, the value  $I + C$ , can, for all practical purposes, be taken as a fairly accurate measure of the total unsaturation introduced.

Further, it was observed that the more unsaturated the product was, as indicated by Hanus number, the greater was the drop in viscosity, consequent on dehydrating castor oil. A relation was also envisaged between the drop in viscosity and the total unsaturation introduced, and it was found that

Percentage dehydration calculated on the basis of Hanus number (400% excess),

$$= 16 V_1 + 26 V_2,$$

where,  $V_1$  = the difference in viscosity, measured at 25° C., between castor oil and D.C.O. and up to a value of 2.5 poises for D.C.O.

and  $V_2$  = the number of units less than 2.5 poises.

Thus, in the case of monomeric (unbodied) D.C.O., the total unsaturation introduced could be evaluated from either of the values  $I + C$  or  $16 V_1 + 26 V_2$ . The distinct advantage of such computation is that the total unsaturation could be determined just from the viscosity of the product, without even resorting to Iodine value determination. Also,  $I + C$  gives an idea of percentage conjugation in the sample, side by side with total unsaturation, which is not provided for by Hanus method. Finally, the formula  $16 V_1 + 26 V_2$  suggests a viscosity of slightly less than 1 poise for a perfectly (100%) dehydrated castor oil.

It might be mentioned here that the extent of dehydration, calculated on the basis of drop in hydroxyl value and water evolved, gave

comparatively higher values than the corresponding Hanus numbers, which may be due to the fact that some side reactions like esterification and other condensation reactions are taking place during dehydration, involving the hydroxyl groups.

With most of the catalysts tried, the extent of conjugation introduced varied from 22-33%, except in the case of anhydrous  $\text{CuSO}_4$ , (4%, at a temperature of 220-257°C. for 30 min.) which gave the maximum conjugation of 45.1%—the resultant D.C.O. being dark-coloured and having as low a viscosity as 1.4 poises (Gardner F), indicating a maximum of 89% dehydration. Also, none of the D.C.O. analysed showed any triple conjugation.

In order to illustrate the calculation using the above formulæ, a few examples from the first author's unpublished work<sup>3</sup> and from that of Priest and Von Mikusch<sup>1</sup> are given in Table I.

### IMPROVING THE STORAGE STABILITY OF DEHYDRATED POTATO AND CARROT POWDER

DEHYDRATED potato and carrots are known to deteriorate during storage under tropical conditions and develop oxidised (stale or perfumed) flavours. These changes are more pronounced in fine powders due to action of oxygen on the comparatively larger surface area exposed. Drying to low moisture levels around 4% for controlling the non-enzymatic browning results in enhancing these changes. In the course of our work on formulating dehydrated soup compositions, we were faced with the problem of stabilizing the potato and carrot powders for subsequent blending into compounded soups.

The dehydrated potato and carrot powders were prepared according to the method described by Bhatia *et al.*<sup>1</sup>

TABLE I

Catalyst	Iodine value		Viscosity	Percentage conjugation	Percentage dehydration from		
	Wijs'	Hanus			I+C	$16V_1 + 26V_2$	Hanus No.
$\text{CuSO}_4^3$	129.0	159.5	1.4 p (F)	45.1	$44.5 + 45.1 = 89.6$	$60 + 28.6 = 88.6$	88.8
Oxalic acid <sup>2</sup>	128.0	146.3	2.0 p (H)	28.8	$43.5 + 28.8 = 72.3$	$60 + 13 = 73.0$	73.1
Typical analysis of a raw D.C.O. made directly from castor oil <sup>1</sup>	141.2	155.5	1.5 p (F-G)	24.7	$56.7 + 24.7 = 81.4$	$60 + 26 = 86.0$	84.0
Sample made in lab according to Munzel patent <sup>1</sup>	145.8	157.0	1.3 p (E-F)	25.3	$61.3 + 25.3 = 86.6$	$60 + 31.2 = 91.2$	85.8

(Calculations are based on the iodine value of Castor Oil at 84.5 and its viscosity at 6.25 poises—Gardner U—at 25°C.)

It is clear from Table I that the three values corroborate fairly accurately, within experimental error, which proves the contention put forth that the percentage dehydration in the case of monomeric D.C.O. could be calculated from any one of the above three values.

University Dept. of C. K. ANANTHESWARAN.  
Chemical Technology, S. V. PUNTAMBEKAR.  
Matunga, Bombay-19,  
February 6, 1963.

1. Priest, G. W. and Von Mikusch, J. D., *Ind. Eng Chem.*, 1940, 32, 1314.
2. Forbes, W. C. and Neville, H. A., *Ibid.*, 1940, 32, 555.
3. Anantheswaran, C. K., *M.Sc. Thesis*, University of Bombay, 1962.

Effect of incorporating antioxidant Tenox II (0.01%), potassium metabisulphite (0.25%) and hydrogenated groundnut oil (5%) was studied by adding them separately and in combination. Tenox II (Butylated hydroxy anisole 67%, Propyl gallate-20%, citric acid-13%) was sprayed as solution in propylene glycol and potassium metabisulphite as aqueous solution on steam-blanching potato and carrot slices before drying in a through-flow dehydrator. Fat was thoroughly mixed in powders of fineness—minus 60 mesh. Experimental samples of powders having 4% moisture were put in pyrex test-tubes which were waxed after fixing ordinary corks. They were stored at  $-18^\circ\text{C}$ . and  $37^\circ\text{C}$ . and examined initially and after 6 and 12 months for organoleptic quality and  $\beta$ -carotene content (in case of carrots only).  $\beta$ -carotene was estimated by the chromatographic method

of the Association of Vitamin Chemists<sup>2</sup> using magnesium oxide and supercel (1:3) in the chromatographic column and 3% acetone in petroleum ether as the eluant.

The results showed that sulphite and Tenox II were not effective in controlling the oxidative changes. Addition of fat, however, resulted in significant improvements. Up to a storage period of one year at  $-18^{\circ}\text{C}$ ., quality of potato powder remained unchanged in all samples, but in case of carrot powder, though no change was noticed up to 6 months, at the end of one year, orange colour was found to be less bright and flavour less pronounced when compared with corresponding samples containing added fat. At a storage temperature of  $37^{\circ}\text{C}$ . at the end of 6 months, potato powder with fat had a better potato flavour than non-fat sample. In case of carrot powder, definite unacceptable perfume-like flavour was noticeable in sample without fat while the sample with fat still retained characteristic carrot flavour. After one year's storage at  $37^{\circ}\text{C}$ ., oxidized perfume-like flavour had developed in both samples of carrot powder but it was less pronounced in sample containing fat. Likewise, oxidised stale flavour developed in case of potato powders was less marked in the sample containing fat. As shown in Table I, incorporation of fat in carrot powder also helped in better retention of  $\beta$ -carotene.

TABLE I

Changes in  $\beta$ -carotene content of carrot powder stored with and without 5% added fat

	Initial value	$\beta$ -carotene mg./100g.			
		$-18^{\circ}\text{C}$ .		$37^{\circ}\text{C}$ .	
		6 months	12 months	6 months	12 months
With fat ..	62.12	54.63	36.10	12.13	10.10
Without fat..	65.42	47.08	29.97	0.38	0.06

This is in line with the report of Bickoff *et al.*<sup>3</sup> with respect to dehydrated alfalfa meal. However, whereas these workers did not find any

beneficial effect of fat on the retention of green colour in dehydrated alfalfa, it was our observation that the stored samples of carrot powder with added fat were definitely deeper in colour than the control.

Since fat is one of the components of compounded soup powders, the practice of storing the potato and carrot bases with added fat fits in conveniently with the production pattern.

Grateful acknowledgement is made to Drs. V. Subrahmanyam, Director and A. Sreenivasan, Deputy Director, for interest shown in this investigation.

Central Food Technological Research Institute,  
Mysore-2, February 6, 1963.  
B. S. BHATIA.  
S. KUPPUSWAMY.  
R. GURURAJA RAO.  
D. S. BHATIA.

1. Bhatia, B. S., Nair, K. G. and Lal, Girdhari, *Defence Science Journal*, 1961, **11**, 15.
2. Association of Vitamin Chemists. *Methods of Vitamin Assay*, 2nd Edn. Interscience Publishers Inc., N.Y., 1951, p. 53.
3. Bickoff, E. M. Thompson, C. R., Livingston, A. L., Van Atta, G. R. and Guggolz, J., *J. Agr. Food Chem.*, 1955, **3**, 67.

### GRAVEL INDICATIONS OF FORMER DRAINAGE IN NELLORE AREA, ANDHRA PRADESH

KING<sup>1</sup> does not record any occurrences of shingles and cobbles in Nellore area whereas Bruce Foote<sup>2</sup> mentions a number of localities in Guntur area (north of the present one). During the course of geological mapping of an area of about 400 sq. miles in Nellore District<sup>3</sup> the author observed them in three areas and studied them in detail in relation to the present drainage (see Table I and Fig. 1).

They occur about a foot below lateritic ferruginous gravels<sup>3</sup> and sand, and vary in thickness from 3 to 4 feet. Gullies and wells nearby point to their areal extension.

Count of 100 samples of these gravels in each of the three places showed the ratio of pebbles (4 to 64 mm.) to cobbles (64 to

TABLE I

No.	Locality	Latitude : Longitude	Approximate altitude above mean sea-level ft.	Approximate altitude of river-bed nearby above mean sea-level ft.	Extent of the deposit
1	Bunthamalada ..	$14^{\circ} 32' 30'' : 79^{\circ} 55' 10''$	85	55 (Penner)	E-W Half a sq. mile
2	Mekalapalem ..	$14^{\circ} 16' 45'' : 79^{\circ} 57' 20''$	60	20 (Uppute;u)	NE-SW Half a sq. furlong
3	Pulivallam ..	$15^{\circ} 37' 30'' : 79^{\circ} 59' 45''$	60	40 (Kaler)	ENE-WSW Half a sq. furlong

256 mm.)<sup>4</sup> varying from 70-30 to 85-15. The largest size encountered (230 mm. diameter) was at Pulivallam. The percentages of oblate, triaxial, prolate and equiaxial forms are approximately 5, 10, 25 and 60 respectively. The ratio of well rounded to the subrounded<sup>4</sup> is as 80 to 20. Percussion scars are to be seen over some of these and there are a few broken rounds too.<sup>4</sup> The gravels are made up of quartzite, vein quartz and chert.

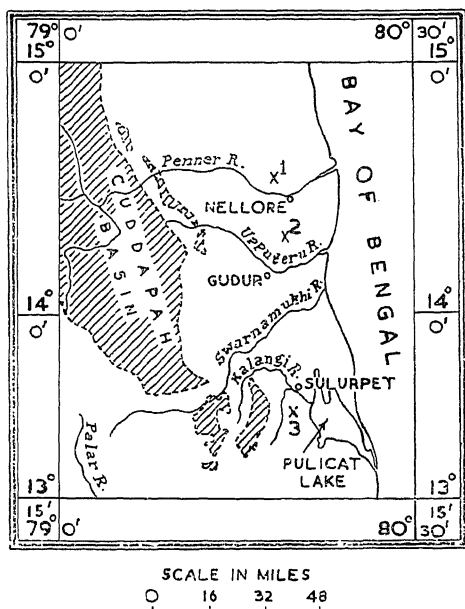


FIG. 1. Location map of gravels. (1) Bunthamalada; (2) Mekalapalem; (3) Pulivallam.

The gravels are regarded as (i) definitely fluvial, (ii) essentially in place, (iii) deposition products of a major stream and (iv) transported over a distance of a few tens of miles. Scattered cobbles in other places were disregarded as they do not necessarily indicate a former stream channel though they may be fluvial in origin.

From the evidence of occurrence of human bones in alluvial cliffs in Guntur area, Bruce Foote<sup>2</sup> concludes that "the river Gundlakamma .... flowed at a level of from 30 to 35 feet higher than the present or was subject to floods of vastly greater magnitude than now occurring". Oscillations of sea-level during Pleistocene are known in the Nellore coast; the rise of level resulting in drowned valleys in Penner River<sup>5</sup> and fall of level leaving shells in the alluvium a few miles inland from the coast.<sup>1</sup> Gravels of the type described above could be brought only during flood times when the rivers

were flowing at an higher elevation and from the lithology of the pebbles it is obvious that they must have been derived from the talus at the foot of the Cuddapah Basin (Fig. 1).

In the case of Penner as well as Upputeru Rivers there is a shift in their courses to the south perhaps maintaining a parallelism that existed in their early history. That the gravels at Bunthamalada (1) and Mekalapalem (2) are those left over by the Penner and Upputeru Rivers respectively in their earlier courses is obvious from the fact that there are no other rivers nearby which could have had high-velocity flow nor are there any abandoned stream courses. There is a gradual slope from these places to the present river-beds containing numerous narrow strips of sand and alluvium. The gravels at Mekalapalem (2) could not have been transported by the Penner since there are some hillocks extending NNW-SSE between this place and the present course of the river.

The gravels at Pulivallam (3) are not due to a similar shift in the Kalangi River or its tributary Kaler from the south, since a small hill rising up to an height of 120 feet above mean sea-level and extending N-S for a distance of 2 miles separates the gravels and the Kaler stream. Cobble grade gravels are more in this area than in the other two. Hence it is surmised that this deposit might be due to a former river not existing now. The present streams contain only washed-up black soil mixed with sand. Gravels are not common. In this connection it has been suggested that Old Palar River might have flowed into Pulicat Lake<sup>6</sup> and the shoal<sup>7</sup> north-east of the Lake could represent the sediments formerly deposited by the above river. It is quite possible that the gravels at Pulivallam could have been emplaced by the Old Palar River.

Similar studies have been made elsewhere<sup>8</sup> and studies of this kind have led to the find of new ground water resources as well as raw material for engineering and industrial uses.<sup>9</sup>

My thanks are due to late Prof. C. Mahadevan for suggesting this problem and to Dr. C. B. Rao for his interest in this investigation. The financial assistance of the Council of Scientific and Industrial Research is thankfully acknowledged.

Geology Department,  
Andhra University,  
Waltair, February 2, 1963.

R. VAIDYANADHAN.

1. Kirg W., *Mem. Geol. Sur. Ind.* (Reprinted 1930), 1880, 16 (2).
2. Bruce Foote, R., *Ibid.* (Reprinted 1930), 1879, 16 (1).

3. Vaidyanadhan, R., *Curr. Sci.*, 1962, **31**, 231.
4. Pettijohn, F. J., *Sedimentary Rocks*, Harper and Bros., New York, 1957, p. 13.
5. Vaidyanadhan, R., *Jour. Geol. Soc. Ind.*, 1962, **3**, 84.
6. Krishnan, M. S., *Geology of India and Burma*, Higginbothams, Madras, 1960, p. 42.
7. —, *Amiralty Chart*, 1961, No. 575.
8. Lucke, J. B., *Jour. Geomorph.*, 1941, **4**, 265.
9. Thornbury, W. D., *Principles of Geomorphology*, John Wiley and Sons, New York, 1957, p. 566.

### SIGNIFICANT VOLCANIC FEATURES OF THE DALMA LAVAS

THE Dalma lavas occur sporadically over a region of more than 2,000 square miles in Midnapore (West Bengal), Singhbhum, Ranchi (Bihar), and Sundargarh (Orissa) districts. A moderate estimate indicates that the Dalma and the Dhanjori lavas, along with their equivalents, must have at one time covered more than 7,000 square miles in Eastern India. They are thus the most predominant plateau basalts in the Precambrian of India, though they have not been recognized as such previously.



FIG. 1. Dalma Volcanic Breccia. South of Chandil

In Thakuranpahari area, Midnapore district, the Dalma lavas are less than 100 ft. thick. As a result a large number of inliers of the underlying Iron-ore series rocks has been exposed revealing contacts with the Dalma lavas. A structure contour map of this surface of contact between the Dalma lavas and the Iron-ore series

rocks shows that it is subhorizontal, the highest dip observed is only 6 degrees.

The Iron-ore series rocks, viz., carbon phyllite, phyllite, chert, and quartzite, are present as inliers within the Dalma lavas and also in the contiguous areas outside the lavas. The bedding dips of these Iron-ore series rocks are always above 63°, and they show steeply plunging fold structures. Since these rocks are overlain by the Dalma lavas with a subhorizontal contact plane, a pronounced angular unconformity is definitely indicated. In this Thakuranpahari area the garnet isograd of the schists of the Iron-ore series runs underneath the Dalma lavas which are epidiorite of the biotite zone. This evidence clearly indicates that orogeny, metamorphism and peneplanation affected the Iron-ore series rocks prior to the extrusion of the Dalma lavas. Therefore the Dalma lavas are neither contemporaneous flows nor are they sills within the Iron-ore series. A similar relationship has also been suggested by Dunn and Dey (1942, p. 387), but they minimized the significance of this unconformity in their final conclusion and described it simply as a "slight overlap" (*Ibid.*, pp. 438-40).

Dunn (1929, pp. 76-77) recognized that the Dalma lavas (now epidiorites) were originally basalts. The available chemical analyses indicate that the Dalma lavas were tholeiitic basalts as shown by the following comparison (Table I).

TABLE I

	Dalma lavas		Deccan Traps	Average Plateau Basalts	
	1	2	3	4	5
SiO <sub>2</sub>	48.97	49.23	51.69	49.70	51.0
Al <sub>2</sub> O <sub>3</sub>	15.75	11.05	14.72	14.24	15.6
Fe <sub>2</sub> O <sub>3</sub>	2.42	2.41	2.83	3.66	1.1
FeO	5.81	9.57	10.87	9.96	9.8
MgO	7.32	7.88	4.18	6.82	7.0
CaO	10.83	11.29	8.20	9.55	10.5
Na <sub>2</sub> O	3.06	4.82	3.25	2.64	2.2
K <sub>2</sub> O	0.16	0.22	0.93	0.70	1.0

Sources of analyses: 1 and 2—Dunn and Dey, 1942. 3—Washington, 1922 and Fermor, 1925. 4—Daly, 1933. 5—Poldervaart, 1955.

Petrographic studies show that relict laths of plagioclase feldspar (basic labradorite) are commonly present and relict augite has also been found, indicating an original mineralogical composition similar to that of the plateau basalts. Common relict textures are intergranular or intersertal, ophitic, subophitic, porphyritic and flow texture. In an individual flow the lower- and uppermost parts show flow texture and intersertal or intergranular texture, whereas the



middle part of the flow shows subophitic to ophitic texture. This textural sequence is a common feature of basaltic lava flows, such as the Deccan Trap basalts (Fermor, 1925).

A volcanic breccia is the predominant rock type in the area south of Chandil. It was previously described as "volcanic breccia and agglomerate" by Dunn (1929). In the later memoir the term "agglomerate" was used only, but Dunn and Dey (1942) did not state why the term volcanic breccia has been discarded by them. In the field south of Chandil the lava has been found to grade into volcanic breccia. These rocks are not agglomerates, as there is no volcanic bomb or any pyroclastics in the groundmass; on the other hand the rocks (Fig. 1) consist entirely of sharply angular fragments of porphyritic amygdaloidal basalt just as the lava flows. The open spaces between the angular blocks are filled in by hydrothermal minerals, e.g., albite, epidote, quartz, etc. In some cases the angular blocks can be fitted in together indicating little relative displacement. This volcanic breccia appears to have originated as block lava (cf. Macdonald, 1953, p. 177). No deformational character has been found to account for the brecciation. No rock type of the present area could be considered as vent agglomerate. Therefore, a volcanic setting of the type as pictured by Dunn (1929, p. 75) and Naha and Ghosh (1960, p. 437) was not present in the area. Pyroclastic rocks of tuffaceous nature have been found, but they are subordinate to lava and volcanic breccia.

It is noteworthy that since the Dalma and the related lavas (Dhanjori lavas, Ongarbira trap, lavas occurring to the north of Noamundi and Dungaposi) are plateau basalts which are generally of the fissure eruption type, central type volcanic vents are not expected. The Newer Dolerite, occurring in the neighbourhood and forming multitudinous dykes in the Singhbhum granite and also in other granites of the region, is a normal tholeiitic dolerite (Krishnan, 1936, p. 119). Newer Dolerite dykes occurring to the north (Dunn, 1929, p. 132; Dunn and Dey, 1942, p. 427) are metamorphosed to epidiorites, some containing biotite just as the lavas (epidiorites) of the Dalma-Dhanjori series. Thus the Newer Dolerites suffered the same degree of metamorphism which affected the Dalma and the Dhanjori lavas—therefore, they must be of the same geological age and should not be considered as the youngest igneous rocks of the region, as has been done by previous workers.

From the foregoing evidence it is concluded that the tholeiitic magma penetrated the Singhbhum granite through fissures, now found as hypabyssal Newer Dolerite, and formed a major volcanic shield on this site. The basaltic lavas spread out far and wide from this area and formed the lavas which are now found in the area around and over the Singhbhum granite.

Our thanks are due to Mr. K. L. Das for providing facilities for field-work in Thakuranpahari area, Midnapore.

University of Calcutta,  
January 18, 1963.

ANIRUDDHA DE.  
D. DASSARMA.  
J. BHATTACHARJEE.

1. Daly R. A., *Igneous Rocks and the Depths of the Earth*, McGraw Hill Book Co. Inc., New York, 1933.
2. Dunn, J. A., *Mem. Geol. Surv. Ind.*, 1929, 54.
3. — and Dey, A. K., *Ibid.*, 1942, 69(2).
4. Fermor, I. L., *Rec. Geol. Surv. Ind.*, 1925, 58, 93.
5. Krishnan, M. S., *Ibid.*, 1936, 71(1), 105.
6. Macdonald, G. A., *Amer. Jour. Sci.*, 1953, 251, 169.
7. Naha, K. and Ghosh, S. K., *Geol. Mag.*, 1960, 97, 436.
8. Poldervaart, A., *Geol. Soc. Amer. Sp. Paper*, 1955, 69, 134.
9. Washington, H. S., *Bull. Geol. Soc. Amer.*, 1922, 33, 765.

#### FOSSIL WOOD RESEMBLING *GREWIA* FROM THE DECCAN INTERTRAPPEAN BEDS OF MAHURZARI NEAR NAGPUR, INDIA

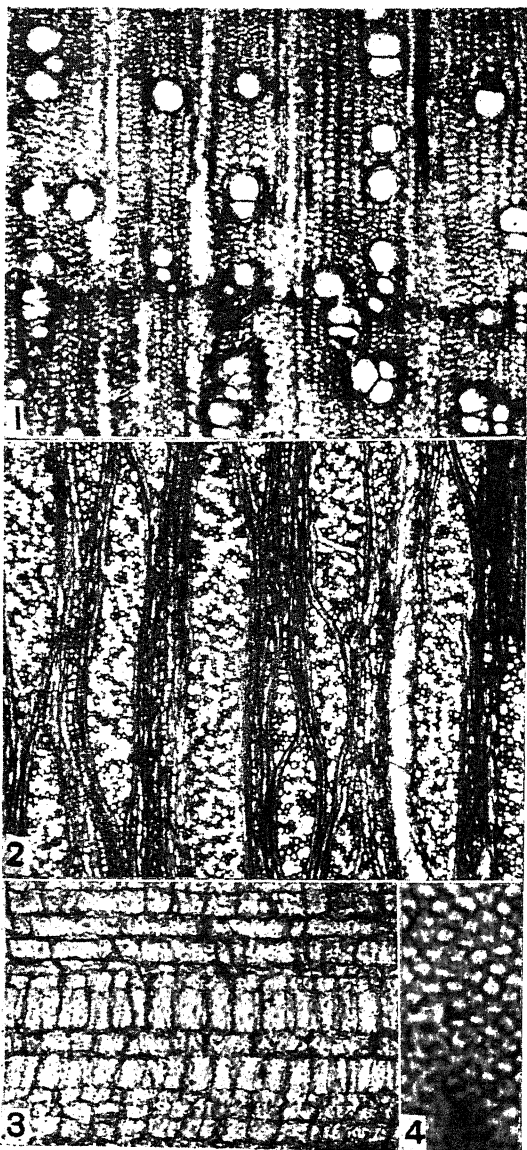
In the present note, a new fossil wood resembling the modern genus *Grewia* L., is described from the Deccan Intertrappean beds of Mahurzari (21° 13' N.; 79° 1' E.) near Nagpur. As far as the authors are aware this forms the first record of the fossil wood of *Grewia* from India and abroad. However, Schuster<sup>1</sup> described a fossil wood as *Grewioxylon swedenborgii* from the Tertiary of East Indies which has been shown to belong to Dipterocarpaceae by Kräusel.<sup>2</sup>

#### *Grewioxylon mahurzariense* SP. NOV.

The present species is based on a small piece of petrified secondary xylem measuring 5 cm. in length and 3 cm. in diameter. It shows the following characters:

Wood diffuse-porous (Fig. 1). Growth rings present, delimited by narrow lines of terminal parenchyma (Fig. 1). Vessels small to medium-sized, t.d. 60–180  $\mu$ , r.d. 60–150  $\mu$ , solitary and in

radial multiples of 2-4 or more cells, sometimes in short double rows and tangential groups or clusters of 3-5 or more (Fig. 1),



FIGS. 1-4. *Grewioxylon mahuratsense* Sp. Nov.  
Fig. 1. Cross-section showing shape, size and distribution of the vessels. Note the terminal parenchyma,  $\times 30$ . Fig. 2. Tangential longitudinal section showing the xylem rays. Note the dissection of the rays and the tile-cells,  $\times 30$ . Fig. 3. Radial longitudinal section showing the *Pterospermum* type of tile-cells.  $\times 125$ . Fig. 4. Intervacular pit-pairs.  $\times 520$ .

5-15 per sq. mm.; tyloses wanting; vessel-members usually short, 285-450  $\mu$  long; per-

forations simple, perforation plates horizontal; intervacular pit-pairs small, 5-6  $\mu$  in diameter, alternate, bordered, with usually lenticular and sometimes coalescent apertures (Fig. 4). *Parenchyma* paratracheal and terminal; paratracheal parenchyma occurring as 1-2 or 3 cells thick sheath round the vessels; terminal parenchyma forming a well-defined, continuous narrow line at the growth rings; storied. *Xylem rays* fine to broad, 1-12 cells and 30-360  $\mu$  broad, 4-7 per mm. (Fig. 2); ray tissue markedly heterogeneous; rays divisible on the basis of size and composition into two types: (a) narrow rays 1-2 seriate and 30-45  $\mu$  broad, heterocellular consisting of procumbent and upright cells, at some places showing tendency towards storied arrangement; (b) broader rays heterocellular, 3-12 cells and 90-360  $\mu$  broad and up to 4 mm. high, consisting of large (colourless) tile-cells of the *Pterospermum* type, interspersed with clusters of smaller procumbent cells (Figs. 2, 3); rays commonly showing various stages of dissection into smaller units. *Fibres* thin to moderately thick-walled, non-septate, aligned in radial rows between the two consecutive rays; irregularly storied. *Ripple marks* present, indistinct.

A survey of all the modern woods with tile-cells<sup>3</sup> indicates that the closest affinity of the fossil wood is with the modern genus *Grewia* L. A detailed microscopic examination of the thin sections of ten species and published descriptions of about seven other species of *Grewia* indicates that the nearest resemblance of the fossil is with *Grewia laevigata* Vahl.

In the modern flora of India the genus *Grewia* is represented in the Deccan Plateau from where the present fossil wood has been collected.

The authors thank Mr. K. Ramesh Rao, Officer-in-Charge, Wood Anatomy Branch, Forest Research Institute, Dehra Dun, for the facilities to consult the extensive collection of slides and samples of modern woods at the Xylarium of the Institute.

Birbal Sahni Institute  
of Palaeobotany,

Lucknow (India), January 2, 1963.

U. PRAKASH,  
RAMESH-DAYAL.

1. Schuster, J., *K. Svensk. Vet. Akad. Handl.*, 1910, 45, 14.
2. Kräusel, R., *Verh. Geol. Mijnb. Gen. Nederland en. Kol.*, 1922, 5, 267.
3. Chattaway, M. M., *New Phytol.*, 1933, 32, 261.

**STUDIES ON THE PITUITARY GLAND  
OF THE INDIAN PALM SQUIRREL,  
*FUNAMBULUS PENNANTI*  
(WROUGHTON)**

THE cytology of the pituitary gland has been reviewed by Purves.<sup>1</sup> Dawson<sup>2</sup> described two tinctorially distinct acidophil cell types in the pituitary glands of 34 mammalian species. In these exhaustive reviews no mention is made of studies on the pituitary of any member of the family Sciuridae. Hoffman and Zarrow<sup>3</sup> have briefly described the changes in periodic acid-Schiff positive cells of the pituitary gland of the ground squirrel *Citellus tridecemlineatus*. The present report includes an account of the cytology of the pituitary gland of the Indian palm squirrel *Funambulus pennanti*.

Pituitaries from sexually mature male and female squirrels collected from the vicinity of the campus of the University of Delhi were fixed in Formol saline and Dawson's fixative. Serial sections cut at 5  $\mu$  were stained in Mallory Triple stain (MTS), Crossmon's modification of the MTS<sup>4</sup> and periodic acid-Schiff-Orange G (PAS/OG) of Purves and Griesbach<sup>5</sup> for the tinctorial differentiation of the various cell types.

The pituitary gland of the palm squirrel is divisible into three distinct parts namely, pars anterior, pars intermedia and pars nervosa. The hypophyseal cleft is distinct and separates the pars anterior from the pars intermedia. The basophil cells are distributed throughout the pars anterior with greater concentrations in the antero-median zone and along the lateral margins. The acidophils are localised mostly in the central portions of the lateral regions and along their inner margin facing the pars intermedia.

Consecutive sections stained in MTS or Crossmon's stain and PAS/OG reveal four chromophil cell types. Two of these belong to the basophil cell class and the other two to the acidophil cell class. This classification is based on stainability, shape, size, granulation and disposition of the cells in the pars anterior. One of the basophil cell types which is coarsely granulated is stained dark-blue with MTS and magenta with PAS. These cells occupy the lateral portions of the pituitary gland and predominantly but not exclusively border the sinusoidal walls. They are round or ovoid with an eccentrically placed nucleus and a prominent nucleolus. Some cells exhibit a well-developed juxtanuclear Golgi apparatus which is composed of a dark staining inner zone surrounded by a clear space. These cells exhibit marked

differences in number between the two sexes, being lesser in the females than in the male squirrels. They increase in number and granulation following gonadectomy and are therefore considered to be responsible for the secretion of gonadotrophic hormones. They are similar to the  $\delta$ -cells of Halmi<sup>6</sup> and the gonadotrophs of Purves and Griesbach.<sup>5</sup> The gonadotrophs represent both the follicle stimulating hormone (FSH) secreting and luteinizing hormone (LH) secreting cells. A tinctorial differentiation between the FSH and LH secreting cells so characteristically seen in the rat pituitaries following PAS-methyl blue staining (Rennels<sup>7</sup>) was not possible in the pituitary of the palm squirrel. Interspersed between the gonadotrophs are some light staining basophils which resemble the gonadotrophs in all respects except in staining intensity. Whether these cells constitute a separate cell type or denote a different stage in the secretory cycle of the gonadotrophs is not clear. The latter is more probable.

The second basophil cell type is large, round or polyhedral and is confined to the antero-median zone of the pars anterior. These cells are light blue after MTS, pink after PAS and purple after the aldehyde fuchsin stain (Gomori<sup>8</sup>). The cytoplasm is finely granulated and shows a large Golgi zone in some cells. These basophils neither show differences in number, distribution and granulation between the two sexes nor do they show any change after gonadectomy or during pregnancy and lactation. They are, however, affected by thyroidectomy. On the basis of these criteria it is inferred that these large, light staining cells secrete thyrotrophin. They are termed thyrotrophs and correspond to  $\beta$ -cells of Halmi<sup>6</sup> and thyrotrophs of Purves and Griesbach.<sup>5</sup>

A tinctorial differentiation is made between the gonadotrophs and thyrotrophs with the performic acid-Alcian blue/PAS/OG technique of Adams and Sloper<sup>9</sup> where the gonadotrophs are stained purple and the thyrotrophs are stained pink.

Two types of acidophils are recognised in the pituitary of the palm squirrel. In the pituitary glands of male and non-pregnant, non-lactating female squirrels one type of acidophil cell is stained red with MTS, and orange in Crossmon's stain and PAS/OG. These are termed orangeophils as suggested by Lacour.<sup>10</sup> They are seen in clusters of 3-8 cells and generally occupy the interior of the inter-sinusoidal spaces. These cells are small, rounded and possess a dense coarsely granulated cytoplasm. They do not fluctuate either in number or in granulation in

mature squirrels of both sexes and in females during pregnancy and lactation. They are considered to be responsible for the production of somatotrophic hormone (STH).

In pregnant females another tinctorially distinct cell type appears which is brown in MTS and purple after Crossmon's stain. These cells are large, coarsely granulated and possess a hypertrophied Golgi apparatus. These are termed carminophils as suggested by Friedgood and Dawson.<sup>11</sup> Their number which is small in early pregnancy increases as pregnancy advances. In late pregnancy and lactation the carminophils dominate the acidophil cell population and are possibly associated with the secretion of luteotrophic hormone (LTH).

The two types of acidophils are stained bright blue selectively with mercury bromophenol blue (Mazia *et al.*<sup>12</sup>) which provides a useful counterstain after PAS for the differentiation of the acidophils. A detailed account of the cytology and histochemistry of the pituitary gland will be published elsewhere.

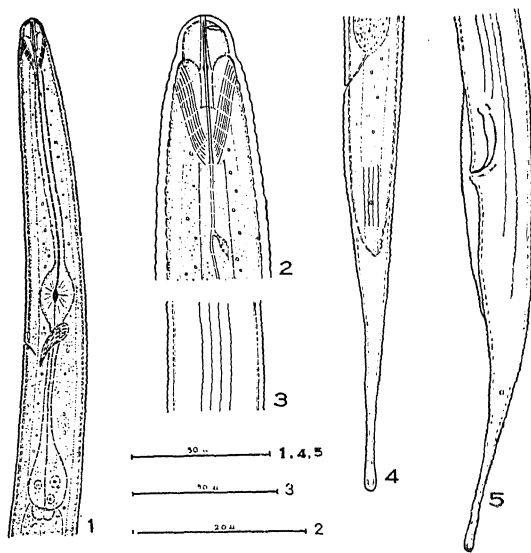
Sincere thanks are due to Prof. B. R. Seshachar for facilities. One of us (G. K. D.) is grateful to The Council of Scientific and Industrial Research for the award of a fellowship. Part of the expenses were defrayed by a grant from the Ford Foundation.

Department of Zoology, M. R. N. PRASAD.  
University of Delhi, GURMEET K. DHALIWAL.  
Delhi-6, May 21, 1963.

# ON *PSILENCHUS NEOFORMIS* N. SP. (NEMATODA: TYLENCHIDA) FROM SOLON (H.P.), NORTH INDIA

THREE females and a single male specimen of a new species of the genus *Psilenchus* de Man, 1921 were found in soil samples collected from around the roots of pomegranate, *Punica granatum* L. from Solon (H.P.), North India. The name *Psilenchus neoformis* n. sp. is proposed for its reception.

*Psilenchus neoformis* N. SP. (FIGS. 1-5)



FIGS. 1-5. *Psilenchus neoformis* n. sp. Fig. 1. Esophageal region of female. Fig. 2. Anterior end of female. Fig. 3. Lateral field. Fig. 4. Tail of female. Fig. 5. Tail of male.

**Dimensions.**—3 females: L = 0.90–1.12 mm.; a = 37–43; b = 6–7; c = 8–9; V = 49–52; Spear = 16–17 μ.

**Holotype** (female): L = 1.12 mm.; a = 37; b = 6.6; c = 8; V = 49; Spear = 17 μ.

**Allotype** (male): L = 1 mm.; a = 45; b = 5.5; c = 7; Spear = 17 μ.

**Description:** *Female* (holotype): Body long, straight and tapering to both extremities. Cuticle and subcuticle marked with fine striations about 1 μ apart. Lateral fields about 1/3 of body diameter, marked by four crenate incisures. Lip region not striated, slightly marked off from body contour. Amphidial apertures elongate, slit-like, located below the contour of lips.

Spear slender and devoid of basal knobs. Orifice of dorsal esophageal gland located at 8.5 μ from spear base. Metacarpus situated posterior to middle of neck. Excretory pore cuticularized, situated at 109 μ from anterior end

1. Purves, H. D., In *Sex and Internal Secretions*. Young, W. C. and Corner, G. W. (eds.). Baltimore, Williams and Wilkins Co., 1961, 1, 161.
2. Dawson, A. B., *Anat. Rec.*, 1963 (Abstr.), 145, 315.
3. Hoffman, R. A. and Zarrow, M. X., *Ibid.*, 1955, (Abstr.), 122, 476.
4. Crossmon, G. C., *Ibid.*, 1937, 69, 33.
5. Purves, H. D. and Griesbach, W. E., *Endocrinology*, 1951, 49, 244.
6. Halmi, N. S., *Ibid.*, 1950, 47, 289.
7. Rennels, E. G., *Ztschr. Zellforsch.*, 1957, 45, 464.
8. Gomori, G., *Am. J. Clin. Path.*, 1950, 20, 665.
9. Adams, C. W. H. and Sloper, J. C., *Lancet*, 1955, 1, 651.
10. Lacour, F., *Comp. Rend. Soc. Biol.*, 1950, 144, 248.
11. Friedgood, H. B. and Dawson, A. B., *Endocrinology*, 1940, 26, 1022.
12. Mazia, D., *et al.*, *Biol. Bull.*, 1953, 104, 57.

of body. Nerve ring near base of metacarpus. Phasmids situated at two anal body diameter below the latitude of anus. Deirids located at level of excretory pore. Hemizonid immediately above the latter. Rectum about one anal body diameter. Tail long, clavate at tip, seven times anal body diameter.

Vulva a transverse slit. Vagina about half the corresponding body diameter. Ovaries amphidelphic and outstretched. Oöcytes arranged in one or two rows. Spermatheca spherical.

**Male** (allotype).—In general morphology and dimensions it is similar to female.

Testis single outstretched. Bursa adanal about  $3\frac{1}{2}$  anal body diameter measuring  $72\ \mu$ . Spicula similar,  $29\ \mu$  long, cephalated and ventrally arcuate. Gubernaculum trough-shaped,  $13\ \mu$  long. Phasmids near middle of tail. Tail similar to that of female.

**Diagnosis and Relationship.**—*Psilenchus* with the above measurements and description: distinctive in having four crenate incisures in the lateral fields; non-striated lip region; spear without basal knobs; orifice of dorsal esophageal gland  $\frac{1}{3}$  to  $\frac{1}{2}$  of spear length from spear base; paired ovaries; phasmids situated at two or more anal body diameter below that latitude of anus; bursa  $3\frac{1}{2}$  anal body diameter and clavate tail in both sexes.

*Psilenchus neoformis* n. sp. comes closest to *P. aestuarius* Andrassy, 1962, but is distinctive in the following features. The orifice of dorsal esophageal gland is  $\frac{1}{3}$  to  $\frac{1}{2}$  of spear length from spear base; the body striations continue on the tail and the bursa is  $3\frac{1}{2}$  anal body diameter (2 times in *P. aestuarius*).

Department of Zoology, M. SHAMIM JAIRAJPURI.  
Aligarh Muslim Univ., ATHER H. SIDDIQI.  
Aligarh, U.P. (India),  
May 1, 1963.

1. Andrassy, I., *Opusc. Zool. Budapest*, 1962, 4, 2-4; 3-8.

2. Thorne, G., *Proc. Helm. Soc. Wash.*, 1949, 16 (2), 37.

#### A NOTE ON THE OXYGEN UPTAKE OF THE CTENOPHORE, *PLEUROBRACHIA GLOBOSA*

THE Ctenophore *Pleurobrachia globosa* occurs in swarms at the surface of Madras coastal waters during the period April-May when the surface salinity is about 34‰ and the temperature is about 30° C. On days when such swarms occur, other zooplanktonic forms like copepods were observed to be rare, apparently due to the carnivorous habits of these forms. There is no

information on the metabolic rate of this tropical species. The oxygen uptake of the temperate species *Pleurobrachia pileus* was studied by Krishnaswamy.<sup>1</sup>

The oxygen uptake at 29° C. was measured using a Warburg constant volume manometer as described by Rajagopal.<sup>2</sup> The diameter of the specimens studied varied from 3 to 7 mm., and the wet and dry weights from 15.88 to 124.00 mg., and 0.6 to 4.6 mg. respectively. The rate of oxygen uptake per individual varied from 0.7864 to 6.0076  $\mu$ l. O<sub>2</sub>/hr. In terms of wet weight, the oxygen uptake range was from 0.003 to 0.517  $\mu$ l. O<sub>2</sub>/mg./hr. and in terms of dry weight the range was from 0.645 to 4.227  $\mu$ l. O<sub>2</sub>/mg./hr.

When live weight and oxygen uptake of *Pleurobrachia* were plotted on a double logarithmic scale, though there was a very wide scatter, a general trend of decrease in respiration per unit weight for an increase in body weight was evident, the slope of the regression line having a value of 0.569 (Fig. 1).

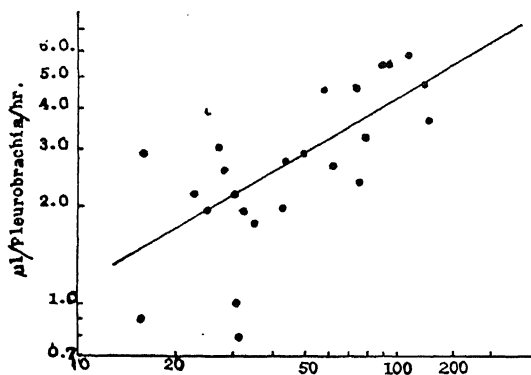


FIG. 1. Showing the relation between live weight and oxygen uptake of *Pleurobrachia globosa*.

The surface area of the individuals varied from 28.3 mm.<sup>2</sup> in the smallest to 154.0 mm.<sup>2</sup> in the largest animal studied. On the assumption that *Pleurobrachia* is a perfect sphere the oxygen uptake per unit of surface area varied from 0.068 to 0.04  $\mu$ l./hr. The surface area has increased in the largest animal compared to the smallest by about 5 times while the respiratory rate per unit area shows a decrease of about 0.5 times only. Very wide variations are found in the intermediate stages. As Krishnaswamy<sup>1</sup> has pointed out the gastro-vascular canals which would increase the surface area considerably, affects the correlation between respiration and surface area.

The rate of oxygen uptake in relation to dry weight of *Pleurobrachia* suggests that respiration is intense. The respiratory rate shows a general relationship with the body weight the respiratory rate per mg. wet tissue decreasing with increasing body weight by 0.569.

My thanks are due to Dr. S. Krishnaswamy for guidance and to the Ministry of Scientific Research and Cultural Affairs, New Delhi, for the award of a Senior Research Scholarship.

Zoological Res. Laboratory, P. K. RAJAGOPAL.\*  
University of Madras,  
January 3, 1963.

\* Present address: Zoology Department, University College, Salisbury, S. Rhodesia.

1. Krishnaswamy, S. (in Press).
2. Rajagopal, P. K., *Proc. Ind. Acad. Sci.*, 1962, 55 B(2), 76.

## ON THE NATURE OF THE PROTEIN OF THE EXOCUTICLE OF ANILO CRA

COMPARED to other crustaceans, very little is known about the structure and chemical composition of the cuticle of isopods. However some information, regarding the cuticular structure, may be inferred from transpiration studies made on terrestrial isopods<sup>1,3,6</sup> suggesting the absence of epicuticular wax in them. The observations of Schmidt<sup>10</sup> on the refractive index of the cuticle of isopod *Idotea* show that a treatment with glacial acetic acid brings about a change in the refractive index of the cuticle indicative of an alteration in its chemical composition resulting from the above treatment. It is of interest to report that in the cuticle of isopod parasite *Anilocra*, decalcification of the cuticle by glacial acetic acid and other decalcifying agents alters the staining reactions.

The soft cuticle of *Anilocra* when sustained with Mallory's triple stain, the epicuticle takes a red colour and procuticle blue, as in other decapod crustaceans. During hardening by tanning, the outer layers of the procuticle is differentiated into a presumptive exocuticle which stains red with fuchsin. After decalcification with dilute glacial acetic acid, 5% formic acid and ammonium citrate-citric acid buffer of pH 4.5, the presumptive exocuticle ceases to stain red and takes up only aniline blue. It has been pointed out by Dennell and Malek<sup>5</sup> that in the exocuticle of *Periplaneta* the red staining is due to a protein impregnating this region preparatory to tanning.

The staining reactions reported in *Anilocra* may suggest that protein responsible for the red staining with fuchsin is affected in some manner by decalcification. A reversion of staining of this protein from red to blue has been reported by Dennell and Malek<sup>5</sup> in the cuticle of *Periplaneta*. The above authors attributed the change in staining to a break-up of aromatic bonds. In *Anilocra* reversion to blue staining noted in the presumptive exocuticle is seen after treatment with not only glacial acetic acid but also 5% formic acid and citrate buffer of pH 4.5. It is suggested that this effect may not be due to break-up of aromatic bonds. It is seen that after treatment of the cuticle with glacial acetic acid, the decalcifying fluid was found to contain a certain percentage of protein along with calcium. Following the method of Greenburg and Mirolubova,<sup>7</sup> estimation of protein in the decalcifying fluid after the above treatment show that there was 2.75 mg.% of protein. Such estimations indicated that after 5% formic acid treatment 3.25 mg.% of protein was present in the decalcifying fluid. Estimations of protein by MicroKjeldahl method as used by Miller and Houghton<sup>9</sup> gave similar values of protein in the decalcifying fluids.

It is seen from the above observations that a certain fraction of protein of the cuticle is removed along with calcium during decalcification. That this protein is really a part of the fuchsinophil protein of the cuticle is indicated by the following tests. After treatment with decalcifying fluid, the results of the histochemical tests with Millon's, xanthoproteic and Hg/nitrite<sup>2</sup> tests for phenols were negative in the presumptive exocuticle indicative of the absence of the fuchsinophil protein which normally is positive to the above tests.

It is suggested that during the formation of the exocuticle the impregnating protein responsible for staining with fuchsin is removed along with calcium during decalcification. This appears to be peculiar to this type for in other crustaceans, decalcification is not followed by the effects reported above.<sup>4,8</sup> Since such a feature has been noted in a parasite, it is suggestive that it may have some relation to the parasitic mode of life.

My thanks are due to Professor G. Krishnan for his kind encouragement and valuable guidance. I am indebted to the Government of India for the award of a scholarship during the tenure of which this work was carried out.

Department of Zoology, GUNASEELAN EDWARD.  
Madras Univ. Extension Centre,  
Madurai-2, February 2, 1963.

1. Anzou, M. L., *Ann. Sci. nat. Zool.*, 1953, **15**, 71.
2. Baker, J. R., *Quart. J. Micro. Sci.*, 1956, **97**, 161.
3. Bursell, E., *J. Expt. Biol.*, 1955, **32**, 238.
4. Dennell, R., *Proc. Roy. Soc. (Lond.)*, 1947, **134B**, 485.
5. — and Malek, S. R. A., *Ibid.*, 1955, **143B**, 427.
6. Edney, E. B., *Biol. Rev.*, 1954, **29**, 185.
7. Greenberg, D. M. and Mirolubova, T. N., *J. Lab. Clin. Med.*, 1936, **21**, 431.
8. Krishnan, G., *Quart. J. Micro. Sci.*, 1951, **92**, 333.
9. Miller, L. and Houghton, J. A., *J. Biol. Chem.*, 1945, **159**, 373.
10. Schmidt, W. J., *Z. Zellforsch.*, 1954, **39**, 537.

### A STUDY OF VARIABILITY IN PEARL MILLET GERmplasm

A LARGE number of wild and related species of *Pennisetum* are available in Africa which according to Stapf<sup>1</sup> has also been considered as the centre of origin of pearl millet. Out of 32 species described by him under the section *Pennicillaria* of the genus *Pennisetum* which are confined to the African continent, only two, namely, *P. typhoides* and *P. purpureum* (Napier or elephant grass) are grown in this

country. A greater range of genetic variability would therefore be expected among materials introduced from Africa as compared to indigenous stocks. A part of the variability has already been in good use as evidenced by the development of several varieties from the African germplasm, Thadani,<sup>2</sup> 'Jamnagar Giant' Pandey,<sup>3</sup> 'Co. 1' Anonymous,<sup>4</sup> 'S. 530' Athwal,<sup>5</sup> and 'Improved Ghana' Joshi *et al.*<sup>6</sup>

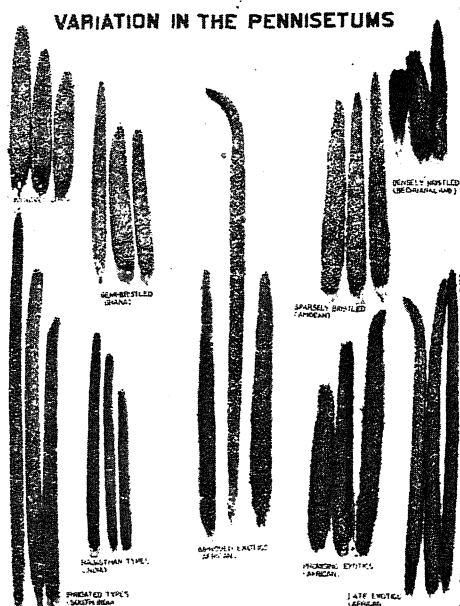
Recognising the potential for exploiting genetic variability for the improvement of pearl millet, the Indian Agricultural Research Institute, the Indian Council of Agricultural Research and the Rockefeller Foundation have collaborated on an intensive, systematic collection of the germplasm from indigenous and exotic sources. The material (presently 1730 samples) including 1086 samples from India, 313 from Africa, and 244 from the U.S.A. is being studied and evaluated. A part of this material comprising 421 cultures (designated as I.P. numbers) was grown during Kharif 1960. The data recorded in respect of the range of variability of a few important agronomic characters are summarised in Table I. The variability of spike characters among promising types is also illustrated in Fig. 1.

It will be observed that in general there are indications of greater variability in respect of

TABLE I  
Range of variability observed in collections of *Pennisetum typhoides* (Burm.) Stapf and Hubb.

Source	Identity of stock	No. of Cultures	50% flowering in days	Plant height (cm.)	Length of spike (cm.)	Girth of spike (cm.)	Compactness of spike	Bristling of the spike
1. Africa								
E. Africa	IP 76-79	4	59-68	234-258	25-38	7-8	Medium	Non-bristled
Kenya (S. Prov.)	IP 158-174	17	55-70	200-310	19-43	6-12	Compact	Non-bristled
Kenya (C. Prov.)	IP 193-248	56	40-102	182-305	14-60	7-13	Loose to Compact	Non-bristled to bristled
Uganda	IP 115-121	7	50-60	221-324	25-27	12-14	Compact	Non-bristled
Tanganyika	IP 122-157	36	40-55	248-340	17-40	7-15	Loose to Compact	Non-bristled to bristled
N. Rhodesia	IP 261, 263, 265	3	45-65	255-277	23-24	7-10	Compact	Non-bristled
S. Rhodesia	IP 249, 250, 264, 467-475	12	60-78	180-300	20-31	5-8	Loose to Compact	Non-bristled to bristled
Nyasaland	IP 175-192	18	62-71	216-297	10-31	7-13	Medium	Non-bristled
Congo	IP 270-280	11	90-110	277-296	23-33	5-7	Medium to Loose	Non-bristled to bristled
Sudan	IP 259, 262, 266-269	6	45-55	200-290	25-27	5-7	Loose	Bristled
N. Nigeria	IP 251, 252,	2	65-100	240-250	21-24	7-10	Loose	Bristled
Ghana	IP 80-82, 260	4	40-45	270-284	27-29	7-11	Medium to Compact	Non-bristled to bristled
2. Australia	IP 457-464	8	50-75	197-224	22-40	5-8	..	..
3. U.S.A.	IP 253, 497, 465	3	50-60	190-200	22-42	5-7	Compact	Non-bristled
4. Netherlands	IP 476, 477	2	79	222-232	26-48	6-7	..	..
5. India	IP 1-75, 83-114, 333-456, 481	232	55-81	170-300	15-46	5-10	Loose to Compact	Bristled to Non-bristled

FLORAL MORPHOLOGY OF  
*BOERHAVIA VERTICILLATA* POIR.



Division of Botany, M. AHLUWALLA.  
 Indian Agri. Res. Institute, K. SHANKAR.  
 New Delhi, December 4, 1962. K. O. RACHIE.

The remaining two central strands are of different size (Figs. 6-8). The smaller one becomes the dorsal trace of the carpal and extends up to the stigma, while the larger, as

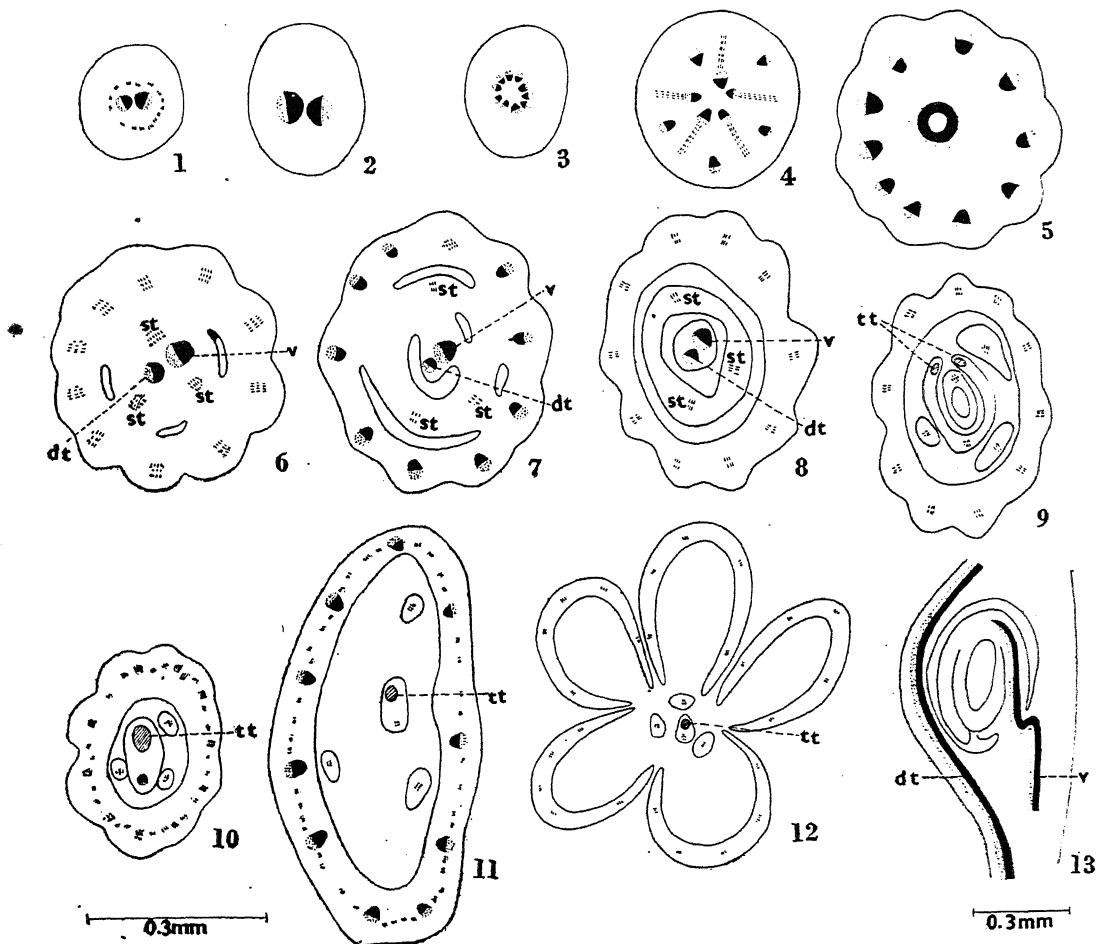
1. Stapf, O., *Flora of Tropical Africa*, Ed. Sir David-Prairie Thistleton Dier Gramineæ, 1934, 9, 954, 1090.
2. Thadani, K. I., *Ann. Rep. Dept. Agri. Sind*, 1937-38, 1940, p. 98.
3. Pande, S. S., *Ann. Rept. Eco. Botanist, Cotton Dept. Agr. C.P. and Berar*, 1937-38, 1938.
4. Anonymous, *Ann. Rep. Dep. Agric. Mysore State*, 1953-54, 1954, Part I.
5. Athwal, D. S., *Proc. Centenary Celebration Academy Agri. Sci. Madras*, 1961 (unpublished).
6. Joshi, A. B., Ahluwalia, M. and Shankar, K. *Indian Fmg.*, 1961, 11(5), p. 12.



in other species of *Baerhavia*<sup>2,5,6</sup> takes a course opposite the dorsal bundle, takes an abrupt turn inwards, enters the funiculus and terminates at the chalazal end of the anatropous ovule (Fig. 13). This strand is inversely oriented (Figs. 6-8, 13) and can be considered to have been formed by the fusion of the ventrals of the carpel. The ventral strand directly becoming ovular supply can be considered to be due to extreme specialization.

to the tissue which gives rise to primary vascular strands.<sup>4</sup> The placentation of the genus is described as basal in the literature. The behaviour of the ventral strand indicates that the present condition is derived from a lateral position.<sup>2</sup> The placentation therefore is best described as sub-basal.<sup>9</sup>

Lam<sup>7</sup> included the centrospermæ under stachysporous angiosperms. The floral apex in *Baerhavia* is not completely used up in the



FIGS. 1-13. Figs. 1-12. Serial transection of flower from pedicel upwards of *Baerhavia verticillata* Poir. FIG. 13. Longisection of ovary showing ovular supply. (dt, dorsal trace; st, staminal trace; tt, transmitting tissue; v, ventral.)

The carpellary margins in *Baerhavia*<sup>2,5</sup> do not fuse for some distance (Fig. 9). At this region a zone of differently staining cells can be marked out in each carpellary margin (Fig. 9). They fuse in the style and extend up to the stigma as transmitting tissue. Bhargava<sup>2</sup> considers this tissue to be procambial in nature, but the term procambium can be applied only

formation of the carpels and the ovules arise from the fused carpellary margins (unpublished observations). These findings as well as the inverse orientation and the abrupt bending of the ventral strand support the classical interpretation of the carpel. Eckhardt<sup>3</sup> also has shown that the ovules in the centrospermæ are phyllosporous.

endosperm. Wall formation commenced 9-10 days after pollination. During this process, in some cases, two or more nuclei became included in a single cell. These subsequently fused and resulted in the formation of a large nucleus.

The root tips of *Nothoscordum fragrans* showed  $2n = 19$  chromosomes. This is in conformity with an earlier report<sup>1</sup> on the chromosome number of the species. Meiotic studies in the dividing pollen mother cells revealed that these were of two types with regard to their chromosome number ( $n = 10$ ,  $n = 9$ ). Thus depending upon the type of male gamete, fusing with the polar nuclei, endosperm nuclei with varying number of chromosomes were formed. A considerable number of metaphase plates showed 30 chromosomes. These arose as a result of the fusion of two polar nuclei having 10 chromosomes each and a male gamete contributing 10 chromosomes. Metaphases with 29, 28 and 27 chromosomes were also observed. Chromosome counts of other metaphases showed the existence of nuclei representing  $6n$ ,  $9n$  and  $12n$  conditions. Some of the endosperm nuclei had aneuploid chromosome numbers mostly around  $3n$ . Metaphases with diplochromosomes were also observed. This would suggest the occurrence of endopolyploidy.<sup>2</sup> Our observations show that one of the causes for the formation of giant nuclei in the endosperm of *Nothoscordum fragrans* is endomitosis. Several aberrations like the multiple bridges, lagging chromosomes, multipolar spindles and chromosome breakages were recorded. The occurrence of such abnormalities indicates the functioning of breakage-fusion-bridge cycle of McClintock.<sup>3</sup>

We are grateful to Professor P. Maheshwari for facilities and encouragement.

Department of Botany,  
University of Delhi,  
Delhi-6, February 1, 1963.

S. L. TANDON.  
B. M. KAPOOR.

1. Levan, A. and Emsweller, S. L., *J. Hered.*, 1938, 29, 291.
2. — and Hauschka, T. S., *J. Nat. Cancer Inst.*, 1953, 14, 1.
3. McClintock, B., *Genetics*, 1941, 26, 234.

#### A NEW BACTERIAL LEAF-SPOT ON *CORCHORUS ACUTANGULUS* LAM.

A BACTERIAL disease inciting extensive spotting on the leaves of *Corchorus acutangulus*, Lam., a common weed closely related to *C. capsularis* and *C. olitorius* from which the well-known fibre jute is produced, has been noticed on the S. B. Garda College ground during September, 1961. The disease appears as a few to numerous

small spots, round to angular, about 1-2 mm. in diameter and coalescing when numerous in close proximity. The spots are more regular on the periphery, probably indicating the hydathodes as venue of infection. Infection spots are often limited by veinlets. The centre of the spots is brownish with clear halo of 0.3 mm. In some cases, cracking in the infected portion is observed and when the dead portion falls off, shot-hole type of symptoms appear. Infection is confined to leaves only. In some cases, bigger veins are also found to be infected. Water-soaked region around the spots are quite noticeable on the lower side also. The lower leaves are more prone to infection, probably due to lack of light, high humidity and low temperature. Infection is more extensive after the heavy rains which seem to splash the infection to healthy lower leaves.

Since no bacterial disease has so far been reported on this plant and since it differs in certain characters from *X. nakatae* (Okabe) Dowson, it is proposed to assign the pathogen a new name, viz., *Xanthomonas nakatae corchori* nov. sp., whose technical description is given below:

*Xanthomonas nakatae corchori* PADHYA AND  
PATEL

Short rods, single, rarely in pairs, gram-negative, motile with a polar flagellum, capsulated, non-spore former, not acid fast; Colonies on potato dextrose agar, yellow, glistening, smooth, convex, butyrous, and pulvinate; Growth on potato dextrose slants, copious, raised and filiform. Gelatine liquefied, starch hydrolysed, casein digested, milk peptonised and litmus reduced; Nitrite not produced from nitrate, indole not produced, hydrogen sulphide and ammonia produced from peptone; V.P. and M.R. tests negative; Citrate utilized but not uric acid; good growth in Fermi's solution; Acid without gas in dextrose, sucrose and mannitol; No growth in salicin; Facultative anaerobe; Optimum temperature for growth is 27-31° C; Thermal death-point is about 52° C.

Pathogenic to *Corchorus acutangulus* only, producing spots on leaves, commonly found in and around Navsari.

Microbiology Dept.,  
S. B. Garda College and  
B. P. Baria Sci. Inst.,  
Navsari (Gujarat State),  
February 4, 1963.

A. C. PADHYA.  
M. K. PATEL.

THYRIOTHECIA OF ASTERINEAE  
FROM THE SOUTH ARCOT LIGNITE,  
MADRAS

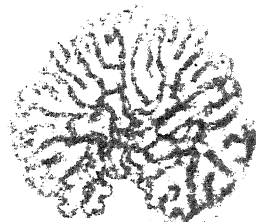
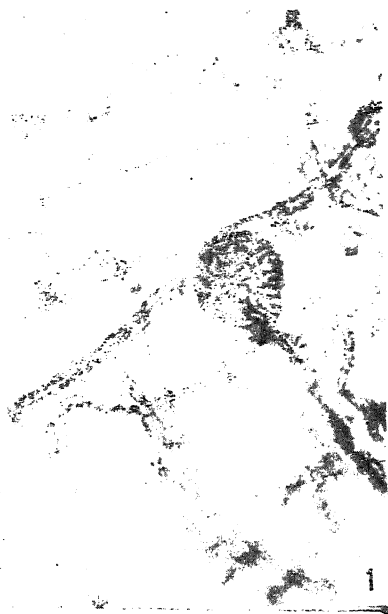
THERE has been very little of detailed systematic investigation of the fruit bodies referable to the Microthyriaceae despite the fairly common occurrence of these fungi in the Indian Tertiary lignites. Rao<sup>1</sup> has recently described a few species of *Microthyriacites* from the Indian lignites. During an investigation of the spore and pollen analysis of the South Arcot lignite (Miocene) from Madras, the author has recovered a galaxy of discoid or shield-like fungal fruit bodies in the macerated detritus. A preliminary study has shown that these are remarkably comparable with the thyriothecia (ascomata) of *Notothyrites*, *Microthyriacites*, and *Asterothyrites* of Microthyriaceae and *Plohmopeltinites* of Micropeltaceae, described by Cookson<sup>2</sup> from the Tertiary deposits of the southern hemisphere.

The present communication particularly deals with three beautifully preserved and morphographically interesting types of thyriothecia showing significant similarities with the fruit bodies of the subfamily Asterineae of Microthyriaceae.<sup>3,4</sup>

*Thyriothecium* Type 1 (Fig. 1).—Fruit body typically shield-shaped, and discoid with a distinct radial pattern, very small, mostly 45–65  $\mu$  across. Free mycelium always present, hyphae light brown, slightly wavy, 3.1  $\mu$  across, septate, septa 12.4–21.7  $\mu$  apart; ramose, hyphopodiate. Hyphopodia, 1-celled, peg-like or sometimes distended and lobed apically. Fruit body brownish, often darkly so, hyphae strictly radiating from 1 or 2 or occasionally 3 centrally placed cubical or squarish cells. Hyphae usually 3–5-celled radially, 15.1–21.7  $\times$  3.1–9.3  $\mu$ , peripheral cells deeply lobed, margin of fruit body more or less fimbriate; no distinct ostiole.

*Thyriothecium* Type 2 (Figs. 2, 4).—Fruit body similar to Type 1 in general organization. Orbicular or shield-shaped with a distinct radial pattern. Free mycelium present, but not profuse, characters similar to the above. Fruit body brownish to yellowish-brown, mostly 70–90  $\mu$ , occasionally up to 120  $\mu$  across, hyphae strictly radiating from 1 or a few central cubical, hexagonal or irregular cells. Hyphae stout, usually of not more than 2–4 cells radially, 24.8–45  $\times$  6.5–12.4  $\mu$ , uniformly thick-walled, apical cells much longer and stouter than the central cells, and typically lobed once or twice, the resultant lobes rounded or notched, margin firm, crenate, sometimes fimbriate; no definite ostiole,

dehiscence by an irregular more or less stellate fissure or rounded aperture.



FIGS. 1–3. Fig. 1,  $\times$  350. Fig. 2,  $\times$  475. Fig. 3  $\times$  475.

Both the above types of thyriothecia are epiphyllous and scattered. The second type of fruit body often exhibits confluent habit. Both these types are quite different from the fossil microthyriaceous fungi known so far. They

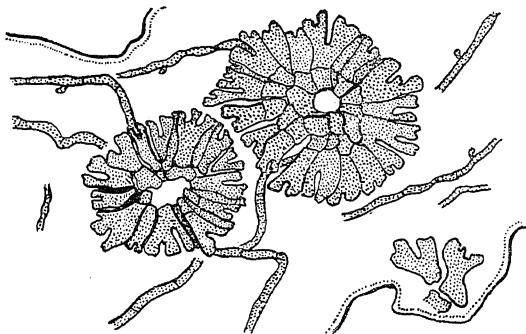


FIG. 4,  $\times 475$

show many similarities in their structural organization with the ascomata of the present-day *Asterina*. In the majority of cases these fruit bodies are seen *in situ* on some leaf cuticles.

*Thyriothecium* Type 3 (Fig. 4).—Fruit bodies linear, scattered, brownish often darkly so  $90\text{--}225 \times 62\text{--}85 \mu$ ; simple or unforked, lower end broad, upper portion smoothly rounded; fruit bodies often elliptical. Free mycelium rather scanty, hyphae non-hyphopodiate. Hyphae of fruit bodies radiating, often from either side of a narrow median longitudinal zone, cells thick-walled,  $5\text{--}12.4 \mu$  long, and  $3.1\text{--}5 \mu$  broad, margin firm, crenate or irregularly sinuous or fimbriate, marginal cells often notched or lobed. Dehiscence by a median longitudinal slit all along the length of thyriothecium.

The linear type of thyriothecium with a radial pattern of hyphae, and a longitudinal dehiscence line fully agrees with the generic definition of *Euthyrites* Cookson<sup>2</sup> but differs from *E. olenites* Cookson in its simple or unforked nature and in the details of its marginal cells.

Ascospores, the characters of which provide diagnostic information for the identification and delimitation of the diverse living Microthyriaceae, have not been usually preserved in close association with the fruit bodies. There are, however, some sporadic instances where a few extremely small ( $12.4 \times 6.2 \mu$ ), 2-celled, brownish spores have been observed in close proximity with the fruit bodies of the first two types on the same piece of cuticle. While it would be rather presumptuous to link such *sporae dispersae* with these ascomata, the possibility that they may have to do something with the latter should not, however, be ignored altogether.

The author is thankful to Dr. C. V. Ratnam of the Neyveli Lignite Corporation Ltd., for the kind supply of material.

Nizam College, C. G. K. RAMANUJAM.  
Hyderabad, January 9, 1963.

1. Rao, A. R., *Felabotanist*, 1958, 7, 43.
2. Cookson, I. C., *Proc. Linn. Soc. N.S.W.*, 1947, 72, 207.
3. Clements, F. E. and Shear, C. L., Hafner Publishing Co., New York, 1931.
4. Hughes, S. J., *Mycel. Pap.*, 1952, No. 48.

### SHEATH BLIGHT OF RICE CAUSED BY *RHIZOCTONIA SOLANI* KUHN— A NEW RECORD IN INDIA

DURING the survey conducted by the senior author in the Punjab State a new disease of rice causing sheath blight was noticed at Gurdaspur in the month of August, 1960. As a result of general observations made on this disease during the subsequent year it was found that it begins to appear in the last week of July when the plants attain a height of about  $1\frac{1}{2}$  feet and the incidence continues up to the maturity of the crop.

*Symptoms*.—The characteristic symptoms are produced on leaf-sheath at irrigation water level. The lesion in its early stages is circular or oblong and dark brown in colour. As the lesion enlarges, the centre changes to almost white or whitish-brown surrounded by somewhat irregular dark brown margin. The dark brown colour at the margin of the lesion diffuses with the green colour of the sheath. The size of necrotic area varies from  $4\text{--}7 \text{ mm.} \times 9\text{--}25 \text{ mm.}$  Two or more lesions may coalesce to involve large area of the sheath. The lesions may totally girdle the sheath. The leaf-blade of affected sheath may dry up from the tip towards the base.

The lesions usually appear at or above the water level and attack is restricted below the ligule. No lesion has been observed on the leaf-blade in natural conditions. However, a lesion can be produced on the leaf-blade by artificial inoculation. The lesions are usually confined to the lower leaf-sheaths at or near the water level. However, under constant humid weather they may occur on upper leaf-sheaths sometimes up to the uppermost, which encloses the panicle. Sclerotia are not observed on or within the leaf-sheath. The culms enclosed by the affected leaf-sheaths were seen to be free from the attack. Figure 1 shows typical symptoms on leaf-sheaths,

**Etiology.**—The fungus was isolated from the diseased material collected from Gurdaspur and was identified as *Rhizoctonia solani* Kuhn [*Corticium solani* (Prill and Del.) Bourd and Galz.]. It grows best on the potato dextrose agar at 30° C. and produces dark brown sclerotia irregular and flattened in shape.



FIG. 1. Showing typical symptoms on leaf-sheaths.

**Pathogenicity Test.**—The fungus is pathogenic to paddy plants in laboratory as well as under the field conditions.

The four-day-old culture on potato dextrose agar was placed in contact with leaf-sheaths of plants raised in earthen pots. The inoculum was covered with cotton wool and maximum humidity was maintained by placing the cover provided with muslin cloth over the plant. Typical symptoms of the disease were observed after four days of inoculations.

For field experiments, the mass culture of the fungus was raised on paddy grains. About 20 gm. of mass culture was placed at the water level, amongst the tillers of the plants raised in the field and all the tillers were tied together loosely with a thread just above the inoculum so that the inoculum does not move away from the plant. Typical symptoms of the disease were seen after 4 days of inoculation.

The causal organism is readily isolated from the artificially infected plants.

Collected from Gurdaspur, 6-8-1960, C. S. Paracer, Herb. Crypt. Ind. Orient No. 28522.

We are grateful to Dr. J. C. F. Hopkins, Director, Commonwealth Mycological Institute, Kew, Surrey, England, for the confirmation of the causal organism as a strain of *Rhizoctonia solani* Kuhn [*Corticium solani* (Prill and Del.) Bourd and Galz.].

Plant Pathology Lab., CHETAN SWARUP PARACER.  
Govt. Agric. College DEVINDER SINGH CHAHAL.  
and Research Institute,  
Ludhiana, Punjab, May 26, 1962.

1. Butler, E. J. and Bisby, G. R. (Revised by R. S. Vasudeva), *The Fungi of India*, Indian Council of Agricultural Research, New Delhi, 1960.
2. Padwick, G. W., *Manual of Rice Diseases*, The Commonwealth Mycological Institute, Kew, Surrey, England, 1950.

#### A PRELIMINARY NOTE ON *EIMERIA BATTAKHI*, N.SP. (PROTOZOA: EIMERIIDAE) FROM DOMESTIC DUCK (*ANAS PLATYRHYNCHOS* *PLATYRHYNCHOS DOMESTICUS*)

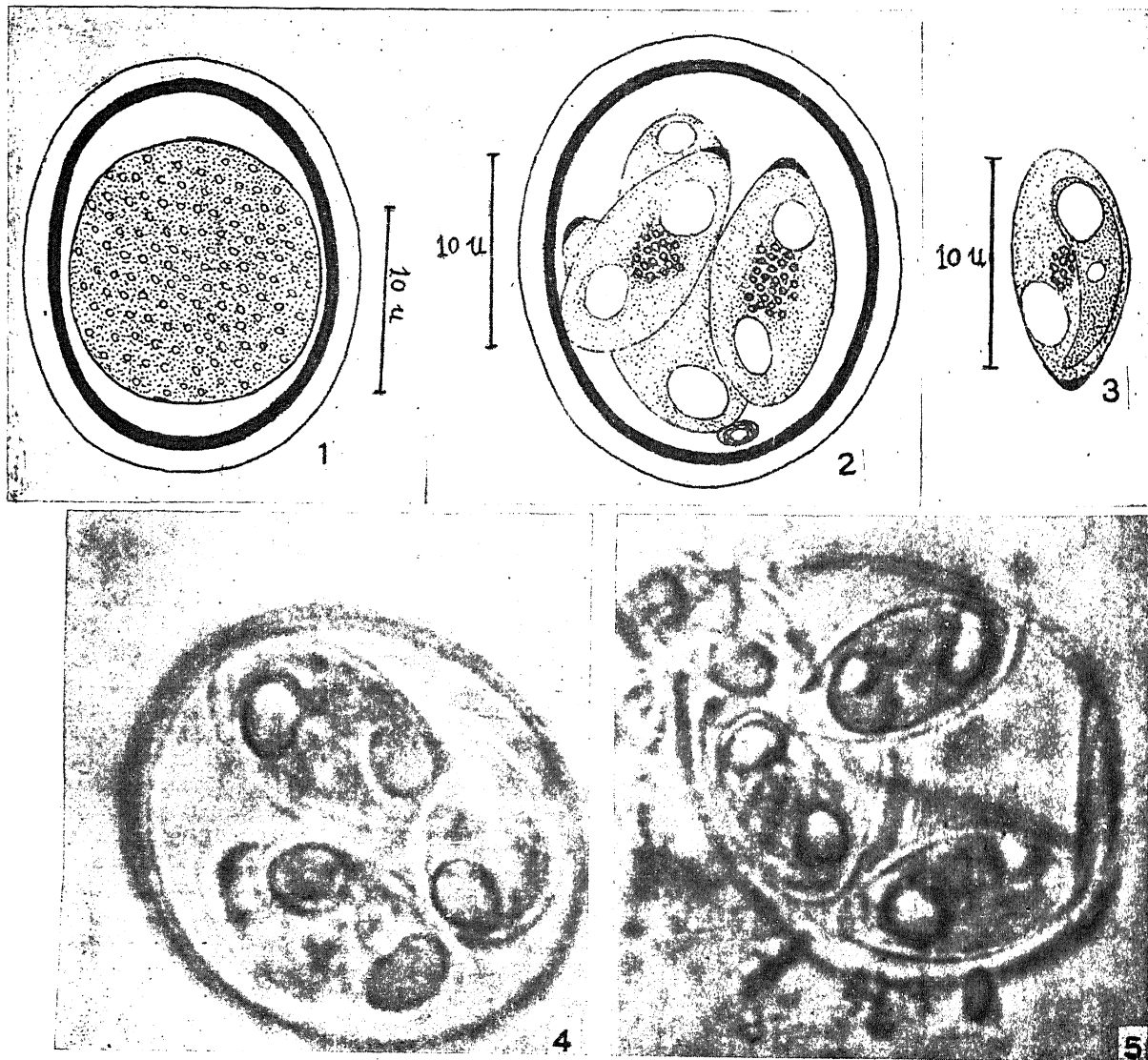
Our knowledge of the coccidia of domestic ducks, according to Levine<sup>2</sup> (1961), is extremely deficient. *Eimeria truncata* (Railliet and Lucet, 1891) Wasielewski, 1904, occurring in the kidney, alone appears to be known from *Anas platyrhynchos platyrhynchos domesticus* (Levine; Lapage,<sup>1</sup> 1961). Tiboldy (1933), as cited by Levine, reported *Eimeria* sp. oocysts in domestic ducks in Hungary and *Eimeria anatis* Scholtyseck, 1955, from mallard, was not found by its author in the domestic ducks examined. According to Lapage, *E. truncata* and *E. anatis* both occur in mallard.

In a search for coccidian oocysts in domestic duck, the droppings yielded, on two occasions, eimerian oocysts. A study of the unsporulated and sporulated forms, herein presented, revealed an infection due to a new species, designated as *Eimeria battakhi*. To study the structural details, oocysts were stained in iodine-eosin

mixture (Christensen,<sup>3</sup> 1938). A few of these stained oocysts were also ruptured under pressure.

*Description.*—Oocysts nearly subspherical to somewhat ovoid. Fifty oocysts measured  $19$  to  $24 \times 16$  to  $21 \mu$ , mode:  $21 \times 18 \mu$ ; their length-width ratio ranged from  $1.13$  to  $1.23$ . Oocyst wall  $1$  to  $2 \mu$  thick, smooth, composed of two layers; the outer one pale yellow to orange in colour, and the inner one dark green with a

shining inner contour. In addition, a colourless to light yellow and nearly of the same thickness as the outer layer, third layer appeared—an optical illusion, as the same disappeared on crushing and staining of the oocyst. Micropyle and polar cap absent. Oocyst polar granule present. Sporont nearly as wide as the oocyst (Fig. 1). Sporulation completed in 24 hours. Sporocysts elongate ovoid, with a single-layered wall. Twenty sporocysts measured  $11$  to  $13 \times$



FIGS. 1-5. Figs. 1-3. Camera lucida drawings. Fig. 1. Showing an unsporulated oocyst. Fig. 2. A sporulated oocyst. Fig. 3. A sporocyst, after rupture of an oocyst. Figs. 4-5. Microphotographs. Fig. 4. A sporulated oocyst showing sporocysts in focus,  $\times 3,400$ . Fig. 5. Sporocysts, after rupture of a stained oocyst, showing polar granule lying near the ruptured wall,  $\times 2,800$ .

6 to 8  $\mu$ , mode: 12  $\times$  7  $\mu$ . Oocystic residuum absent. Sporocystic residuum present between the two sporozoites. Stieda body small, appearing as a thickening at the narrower end of the sporocyst. Sporozoites elongated, with one end broad and rounded, and the other narrower and pointed (Figs. 2 and 4). Ten sporozoites measured 10  $\times$  2 to 3  $\mu$ , nucleus central, cytoplasm dark and granular, with one or two hyaline globules (Figs. 3 and 5).

The oocysts of *E. battakhi* n.sp. can be distinguished from those of *E. truncata* by the latter's typical morphology, viz., small end narrow and truncated, presence of a micropyle and a polar cap. The oocysts of *E. anatis* are distinguished by their smaller size, possession of a micropyle, and by the absence of a polar granule. The only details in case of *Eimeria* sp. reported by Tiboldy are known for the size and shape of the oocysts which as such are of no diagnostic value.

Thanks are due to the Indian Council of Agricultural Research, New Delhi, for the award of a Junior Fellowship to one of us (J. P. D.).

Department of Parasitology, J. P. DUBEY.  
U.P. College of Veterinary B. P. PANDE.  
Science and Animal Husbandry,  
Mathura, (U.P.), January 11, 1963.

1. Lapage, G., *Parasitology*, 1961, 51, 1.
2. Levine, N. D., *Protozoan Parasites of Domestic Animals and of Man*, Burgess Publishing Company, Minnesota, 1961, p. 412.
3. Christensen, J. F., *J. Parasitology*, 1938, 24, 453.

#### CUTICULAR SHEATH IN THE EMBRYO OF *EUDERUS AGROMYZAE* GANGRADE

THE embryos of insects are known to be invested with thin cuticular membranes. Snodgrass (1935) mentioned about the occurrence of embryonic membranes in all insects with incomplete metamorphosis and in some holometabolous forms. Smith (1922) described it in three species of *Neuroptera* and Sikes and Wigglesworth (1931) noted it in the meal worm, *Tenebrio molitor*.

During the study of hatching of the eggs of *Euderus agromyzae* which is a solitary ecto-parasite of *Melanagromyza obtusa* Malloch, the embryo was seen invested in an embryonic membrane (Fig. 1). The embryo began to move forward leaving a small gap between itself and the posterior end of the egg shell at 2-0 p.m.

After about 15 minutes the head of the grub had pressed itself against the cephalic end of the egg and distended it, though actual bursting of the egg took place after another 15 minutes, when both head and prothorax were seen protruding out. By 2-45 p.m. the mesothorax was clearly out, and by 3-0 p.m. the metathorax and the first three abdominal segments were out. It was at this time that the larva began movements from side to side. Throughout the process of hatching, the embryo maintained a

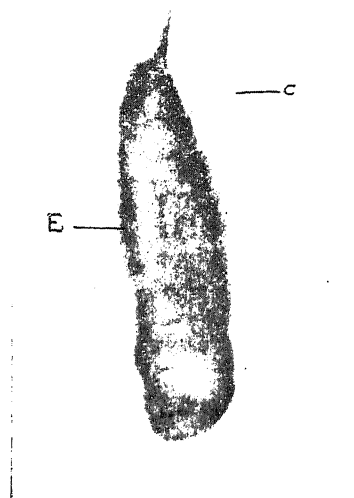


FIG. 1. Membrane investing the embryo of *E. agromyzae* Gangrade.

C = Chorion; E = Embryo

fine thread-like connection with the posterior end of the egg, which broke at 3-20 p.m. The larva finally wriggled out of the egg leaving behind an empty glistening white egg shell. The membrane remained inside the egg shell.

The shedding of the embryonic covering before hatching suggested that an embryonic moult was undergone in *Euderus agromyzae*. This is probably the first record of an embryonic moult in the Hymenopterous insects.

College of Agriculture, G. A. GANGRADE.  
Jabalpur, January 17, 1963.

1. Sikes, Enid, K. and Wigglesworth, V. B., *Quart., Jour. Micr. Sci.*, 1931, 74, 165.
2. Smith, R. C., *Ann. Ent. Soc. America*, 1922, 15, 169.
3. Snodgrass, R. E., *Principles of Insect Morphology*, 1935.

## REVIEWS

**Recent Progress in the Chemistry of Natural and Synthetic Colouring Matters and Related Fields.** Edited by T. S. Gore, B. S. Joshi, S. V. Sunthakar and B. D. Tilak. (Dedicated to Professor K. Venkataraman in Commemoration of his Sixtieth Birthday—June 7, 1961, Pp. XXIII 659, [Academic Press, Inc. (London) Ltd.], 1962. Pp. xxvii + 659. Price \$ 24.00.

This valuable book has been published on the occasion of Professor K. Venkataraman's 60th Birthday to commemorate his contributions to organic chemistry and to the Indian dyestuffs industry. Distinguished organic chemists from many parts of the world have contributed interesting and valuable papers which are authoritative in character, many of them reviewing matter which is difficult to get from other sources and giving an insight into recent developments in important fields, as for example, the paper of Sir Robert Robinson on 'Synthesis in the Brazilin Group' where literature is highly spread out and difficult to piece together. The book is, therefore, an important addition to the literature of Organic Chemistry.

The volume contains 49 papers by 86 contributors. More than half of the papers (26) relate to natural colouring matters; 12 papers deal with synthetic dyes and the remaining 11 papers relate to other natural products like terpenes and alkaloids, and ring compounds which have anti-tubercular and carcinogenic properties. Thus, it could be seen that the main bulk of the matter relates to the field indicated in the title of the book, viz., natural and synthetic colouring matters. In the articles on synthetic dyestuffs, the chemical as well as applied aspects are discussed from which the reader can get an idea of the objectives and approaches in this field in recent years. Among the papers on natural colouring matters there are so many which are so good that it is difficult to single out individual ones for special mention. The important contribution of Sir Robert Robinson has already been mentioned. A detailed account of insect pigments 'Ommochrome' is given by Butenandt and Schafer. There are two articles on carotenoids; one with the title 'Bisdehydrocanthaxanthin' is by Faigle and Karrer, and the other is an excellent review by Isler and collaborators under the title 'Recent Developments in the Carotenoid Field'. Thomson's article on 'Naturally Occurring

Black Pigments' deals with a topic of growing importance. Articles on quinones include 'Hooker's Researches on Lapachol' by Fieser, 'Some Natural Anthraquinone Colouring Matters' by Joshi, 'Constituents of Coprosma Genus' by Briggs, and 'Bianthraquinones and Related Compounds produced by Moulds' by Shibata. There are 14 articles of current interest on flavonoids. Two of them relate to Biflavones and two others to Proanthocyanidins which are of recent development. Biogenesis of isoflavones and related compounds is discussed by Grisebach. Another subject of current interest is C-glycosides; an example of this group is mangeferin and its chemistry is discussed by King and his collaborators.

The volume contains an excellent collection of articles on varied topics of current interest and it has been brought out in good form according to the high standards of the Academic Press. The editors have done a good piece of work to celebrate the 60th birthday of an eminent leader in Organic Chemistry.

T. R. S.

**Quantum Theory.** Edited by D. R. Bates. Volume I: *Elements*; Pp. xi + 447, Price \$ 10.00; Volume II: *Aggregates of Particles*, Pp. xi + 475, Price \$ 11.00; Volume III: *Radiation and High Energy Physics*, Pp. xii + 402, Price \$ 10.00. (Academic Press, New York and London), 1962.

The development in quantum theory during the last three decades has been so phenomenal that the days of containing the subject in a single text-book are gone, but instead several volumes are needed to incorporate even the fundamental concepts of the subject. The idea of the publishers in bringing out three volumes in quantum theory entitled "Elements", "Aggregates" and "Radiation and High Energy Physics" is therefore a laudable step in the right direction and will be welcomed by all physicists.

Each volume of this series is a compilation of survey articles written by specialists on restricted topics. The volumes, on the whole, provide a balanced treatment of quantum theory, both its fundamentals as well as the important applications.

Volume I deals with non-relativistic wave mechanics and matrix mechanics, and provides



an extensive survey of the exactly soluble problems of quantum mechanics, stationary perturbation theory and collision problems. The first two chapters by Margenau give an exposition of the basic principles of quantum mechanics—the operator formalism, stationary states, the probability interpretation of the square of the wave function and the spin of the electron. The next two chapters by R. A. Buckingham deal with the exactly soluble bound state problems and the continuum states. The inclusion of a chapter on the continuum states is a novel feature of the book, because this topic is usually left out in text-books. Chapter 4, by Dalgarno, is a survey of the stationary perturbation theory and provides formulæ for the eigenfunctions and eigenvalues of any order of a perturbed system. The next chapter by B. L. Moiseiwitsch deals with the variation method, which is a powerful tool for solving the wave equation. The section on two electron system incorporates some recent advances made by Pekeris on the evaluation of the energy levels of  $\text{He}^+$  ions. The last chapter of the volume, by E. H. S. Burhop, gives a detailed account of the theory of collisions.

Volume 2 deals with the application of quantum mechanics to atomic systems, molecules, solids and liquids. It starts with an excellent survey on "Complex Atoms" by M. J. Seaton, in which the application of the Hartree-Fock equations to atoms or ions is discussed in great detail. Chapter 3 by Coulson and Lewis gives an account of the fundamental principles of chemical binding such as the valence bond and molecular orbital methods, multiple bonds, hybridisation, etc. A reader of this chapter however cannot help feeling disappointed at the lack of the same high standard of lucidity and thoroughness, which mark Professor Coulson's book on valence. The same feeling that the authors of the book have not taken their task seriously takes possession of the mind of a casual reader on looking at the chapter entitled "Theory of Solids", since this chapter can also hardly be regarded as complete. Besides, this volume has a few other chapters on group theory, quantum statistics, molecular spectra and the quantum mechanics of liquids.

Volume 3 deals with quantum field theory and nuclear structure. The first chapter deals with the Dirac equation and its properties, the Foldy-Wouthuysen transformation and relativistic wave equations. Chapters 2 and 3 deal with quantum electrodynamics and give an exposition of the ideas underlying field quantisation, S-matrix theory and Feynmann graphs. The

chapter entitled "Nuclear Structure" by K. A. Brueckner gives an excellent account of the many body perturbation method as applied to nuclear matter. In the opinion of the reviewer this chapter is the most impressive review article in the three volumes and stands out for the clarity of exposition and lucidity. Besides, the volume contains two more chapters, one on meson theory and nuclear forces, and another on "Hidden variables in quantum theory".

These volumes provide a complete account of the important developments in quantum mechanics, and will be immensely useful to post-graduate students as well as research workers in theoretical physics.

K. S. VISWANATHAN.

---

*Advances in X-Ray Analysis* (Vol. 5). Edited by W. M. Mueller (Plenum Press, Inc., 227 West 17th Street, New York 11), 1962. Pp. xi + 564. Price \$17.50.

The tenth annual conference on 'Applications of X-Ray Analysis', sponsored by the University of Denver, Colorado, was held on August 7-9, 1961. Fifty-six papers were presented by about a hundred active workers in the various fields of X-ray technology, and discussed by the three hundred participants who attended the Conference. Forty-eight of these papers together with the discussions that followed each paper are included in this volume.

The chief purpose of these annual conferences is to give to the participants the opportunity to learn not only the latest developments in particular fields of study but also, in many cases, to come to know new and unpublished results and achievements. The publication of the proceedings of the conference, including the subtle discussions, extends this opportunity to a much wider audience, namely, the researchers in X-ray technique and applications spread all over the world. To the neophytes it helps to give an over-all picture of the latest in this field.

The volume opens with the article "Twenty years of progress in X-ray diffraction techniques" by Professor Andre Guinier of the University of Paris. In this article Professor Guinier has neatly summarised the latest developments in crystalline phase analysis and the study of lattice defects by X-ray techniques. The second article is by Professor Hans Nowotny of the University of Vienna on "Crystal structure and stability of refractory phases". The paper deals with some recent investigations on beryllides.

borides, carbides, aluminides, and germanides of transition metals with special reference to hafnium and uranium compounds.

X-ray diffraction and emission spectroscopy techniques have received equal emphasis in these papers. High and low temperature studies in X-ray diffraction, improved techniques for precision measurements, and applications of milli- and micro-probes are some of the topics covered.

The following titles selected at random will give the reader an idea of the variety of subjects discussed at the Conference. The lattice parameters of iron-ruthenium solid-solution alloys; The determination of crystallite size and size distribution from broadened X-ray diffraction lines; X-ray studies of preferred orientations and stress-strain relations in rapidly deformed copper; Effect of impurities on kaolinite transformations as examined by high-temperature X-ray diffraction; The geometrical representation of ternary alloys and its applications to X-ray fluorescence and microprobe analysis; Precision of X-ray emission measurements in the determination of low alloy steels with an X-ray spectrograph; Application of X-ray fluorescence analysis to process control; Electron probe X-ray spectrograph: design, evaluation and application.

A. S. G.

**Electromagnetic Waves in Stratified Media.** By James R. Wait. (Pergamon Press), 1962. Pp. x + 372. Price.

This book is the third volume of the *International Series of Monographs on Electromagnetic Waves* edited by A. L. Cullen, V. A. Fock, and J. R. Wait. Much of the subject-matter is based on the author's own investigations and some of it have been published previously. The book has been written primarily as a reference work. As such, it fulfils a need. The subject is important and the graduate student has to be exposed to the current thinking on the subject. For this purpose, the teacher will find this volume handy. The book is also useful to the research worker in the field as it provides a good list of references to original and review papers.

The subject-matter is spread over a dozen chapters. Reflection of electromagnetic waves from (i) horizontally stratified media and (ii) inhomogeneous media with special profiles, mode theory of wave propagation including VLF and ELF propagation, propagation through stratified magneto-plasma media, super-refrac-

tion and tropospheric ducting are some of the important items that come up for detailed treatment. The printing and get-up of the book is very good. There is a subject index and an authors' index. Both of them have been prepared with some real effort.

Although the physical aspects of problems do come up for some consideration and there are comparisons made with experimental data, the book as a whole can be considered to provide a formal mathematical treatment of the behaviour of electromagnetic waves in media whose properties vary in one particular direction. This variation may be abrupt or continuous. In this sense, the media are classified as stratified. This is an idealization of many situations which occur in nature and it does assist in understanding problems of practical importance. Extensive critical discussions of the physical situations from the practical standpoint could have added to the value of the book. It merits a place in Physics, Mathematics and Electrical Engineering libraries.

S. V. C.

**Use of the Chemical Literature.** Edited by R. T. Bottle. (Butterworths, London), 1962. Pp. 231. Price 35 sh.

With the increasing activity in chemical research all over the world, literature dealing with the several branches of chemical knowledge is accumulating at a terrific rate and it is physically impossible to read and assimilate all the information or even all of a single branch. With massing of this knowledge in books and periodicals through research papers, review articles, compendia, abstracts and digests, and in different languages, and in different libraries, the problem of location, selection, collection and translation of information becomes big. This is all the more so as the inter-disciplinary boundaries sink and multi-disciplinary approaches to research problems become necessary, which in turn lead to scattered publications. To aid the research worker under such a situation, catalogues and guides have been published from time to time. The book under review is one such guide. It comprises fifteen chapters and two appendices written by several authors, and an index. The chapter headings are:

Introduction; Libraries and their use; Chemical periodicals; Translations and their sources with special reference to Russian literature; Abstracts, abstracting and information retrieval; Background information; Use

of standard tables and handbook of physical data; Inorganic Chemistry; Nuclear Chemistry; "Beilstein's Bandbuch" as a source of information on organic chemistry; Other reference works in organic chemistry; Use of patent literature; Government and trade publications of interest to the chemist; History of chemistry; and Practical use of the chemical literature.

The appendices contain a brief glossary of the terms used in photocopying and microfilming as well as suggestions for practical work with examples. This is a very useful book for the research worker both in academic institutions and industrial establishments.

B. H. IYER.

**Natural Gas and Methane Sources.** By James Lawrie. (Chapman and Hall, London), 1961. Pp. xiv + 204. Price 35 sh.

In this small book of 200 pages containing 23 plates and 28 figures, James Lawrie discusses in a nice, explanatory style each and every aspect of Natural Gas. The formation, discovery and occurrence of sources of methane, the liquefaction, the by-products and even the future development of natural gas have been considered. The book makes interesting reading, especially the story of the 'Methane Pioneer', the first ship to transport across the sea, from Gulf coast Oxfiolds to England 1,400 bbl. of its original cargo of 32,000 bbl. of liquid gas at  $t = -260^{\circ} \text{F}$ .

It is a highly instructive book, and is essential for anyone who desires to learn about natural gas—a topic highly discussed and rapidly developing in this country.

G. B.

**The Movement of Fin and Blue Whales within the Antarctic Zone.** By S. G. Brown. *Discovery Rep.*, XXXIII. (Issued by the National Institute of Oceanography, U.K.; Cambridge University Press, London), 1962. Pp. 1-54. Price £ 1-10-0.

In this interim report, the author has assembled considerable data derived as a result of whale-markings during the pre-war and post-war years. The recoveries throw some light on the distribution and movements of the fin and blue whales in the Antarctic zone. There is a tendency for the fin whale to return to the same region year after year besides a great deal of movement in the circumpolar direction; in particular, large longitudinal movements occur in both fin and blue whales within the

whaling season and from one area to another, not observed in pre-war records. It would appear that there is no limit to the range of dispersal in either of the whales. The division of the Antarctic into six equal geographical areas, of considerable value for analysis of data, is examined in relation to the movement of whales between these areas. The observations suggest that most of the areas have some reality and reflect a division of the two species into groups. Some circumstantial evidence is adduced for migratory movements, from breeding-grounds in the warmer waters to feeding-grounds in the Antarctic waters. Continued markings and recoveries will considerably go to present a clearer picture of the movements of these whales. The paper should be of considerable interest to fishery biologists in general and exploiters of the whale fishery in particular.

R. SUBRAHMANYAN.

**Insect Pathology—An Advanced Treatise.** Vol. 1. Edited by A. Steinhaus. (Academic Press, New York and London), 1962. Pp. xvii + 661. Price \$ 19.00.

Professor Steinhaus has excellent qualifications for editing the treatise and he has made good use of them. Indeed, this volume is a worthy successor to his earlier book *Principles of Insect Pathology* and is very welcome when one considers the scarcity of books on the subject as against the rapidity with which literature has accumulated over the past decade and a half.

The volume under review is composed of 17 chapters and is intended to give advanced information on the subject of insect "Pathology" in relation to physical injuries, chemical injuries, nutritional diseases, genetic diseases, tumors, normal flora, pathogens of vertebrates and plants, immunity, physiopathology and histiochemistry, predispositions and interrelationships in insect diseases, nuclear polyhedrosis viruses, cytoplasmic viruses, granuloses and rickettsioses. All the chapters, written by active investigators in respective fields, are well documented and suitably illustrated. Collectively they make a contribution to science and would serve as an invaluable source of reference to pathologists, entomologists and other researchers interested in the field of biology and medicine.

The book, which maintains the quality of production typical of Academic Press, will receive appreciation from all those interested in the subject.

J. V. B.

**Aquatic Angiosperms.** By K. Subramanyam. (Botanical Monograph No. 3, Council of Scientific and Industrial Research, New Delhi), 1962. Rs. 20-00; sh. 40; \$ 6.00.

It is always a pleasure to see a well-written and well-prepared book on a subject of special importance, and in the present case this work on aquatic angiosperms is a welcome addition to any botanical library, big or small. The author of this book has spared no pains to bring together all the source material required for a work of this type, based on his own careful and painstaking observations in the field and on his knowledge of all relevant literature on the subject. Ecologically, aquatic angiosperms have always been a fascinating group on account of their characteristic forms and striking adaptations to the medium in which they live, and Dr. Subramanyam has endeavoured successfully to bring together in the monograph the most significant and interesting features exhibited by the better known flowering plants belonging to this group. Apart from keys and taxonomic descriptions of families, genera and species, which themselves are based on the author's personal observations on fresh living material in the field made possible during his extensive botanical tours in the country, the monograph contains much valuable and delightfully readable information on the embryology, pollination, ecology and medicinal importance of the plants dealt with, together with chromosome numbers culled out and compiled from all available literature. The illustrations are very well executed and enhance the importance of the book considerably. An extensive bibliography and a general index make this book a handy reference work. The book is moderately priced so as to be within easy reach of all interested in this ground of flowering plants.

ESBEEKAY.

### Books Received

*Elements of Physical Chemistry.* By S. Glasstone and D. Lewis. (Macmillan & Co. Ltd., Madras-2), 1962. Pp. v + 758. Price 25 sh.

*Encyclopedia of Chemical Technology* (2nd Edition) (Vol. I). By Kirk-Othmer. (John Wiley & Sons, New York-16, N.Y.), 1963. Pp. xix + 990. Price \$45-00 each volume.

*Proceedings of the International Astronomical Union Symposium No. 16—The Solar Corona.* By J. W. Evans. (Academic Press, New York), 1963. Pp. xi + 344. Price \$14.00.

*One Two Three Infinity.* By G. Gamow. (Macmillan & Co. Ltd., Madras-2), 1962. Pp. xii + 340. Price 16 sh.

*The Case Against the Nuclear Atom.* By D. B. Larson. (North Pacific Publishers, P.O. Box 5044, Portland 13, Oregon), 1963. Pp. v + 139. Price \$4.50.

*The Quantum Theory of Many-Particle Systems.* Edited by H. L. Morrison. (Gordon & Breach, 150 Fifth Avenue, New York-11), 1963. Pp. xiv + 345. Price \$4.95.

*The Mechanical Investigations of Leonardo Da Vinci.* By Ivor B. Hart. (California University Press, Calif.), 1963. Pp. xi + 240. Price 17 sh.

*International Review of Cytology* (Vol. 14). Edited by G. H. Bourne and J. F. Danielli. (Academic Press, New York), 1963. Pp. x + 414. Price \$16.00.

*British Medical Bulletin* (Vol. 19), No. 2, May 1963—*Peripheral Circulation in Man.* (The Medical Department, The British Council, London W. 1), 1963. Pp. 97-168. Price £ 1.10 sh.

*The Biology of Cestode Life-Cyces.* By J. D. Smyth. (The Commonwealth Agricultural Bureaux, Farnham Royal, Bucks, England), 1963. Pp. 38. Price 10 sh.

*Geophysics.* Edited by C. Dewitt, J. Hieblot and A. Lebeau. (Gordon & Beach, 150 Fifth Avenue, New York 11), 1963. Pp. xiv + 624. Price \$10.50.

*The Identification of Molecular Spectra.* By R. W. B. Pearse and A. G. Gaydon. (Chapman & Hall Ltd., 37 Essex Street, London W.C. 2), 1963. Pp. xi + 347. Price 120 sh.

*Models and Analogies in Science.* By M. B. Hesse. (Sheed & Ward Ltd., London W.C. 2), 1963. Pp. 150. Price 15 sh.

*Directory of British Scientists.* (Ernest Benn Ltd., London E.C. 4), 1963. Pp. xxxii + 1289. Price not given.

*Nuclear Power Today and Tomorrow.* By K. Jay. (Methuen & Co. Ltd., London W.C. 2), 1963. Pp. 270. Price not given.

*Phthalocyanine Compounds—ACS Monograph 157.* By F. H. Moser and A. L. Thomas. (Reinhold Pub. Corp., New York 22, N.Y.), 1963. Pp. xiii + 365. Price \$18.00.

*Understanding Physics Today.* By W. H. Watson. (Cambridge University Press, London N.W. 1; India: Macmillan & Co., Madras-2), 1963. Pp. xiii + 218. Price 30 sh.

*Ionic Processes in Solution.* By R. W. Gurney. (Dover Publications, New York-14), 1963. Pp. ix + 275. Price \$1.75.

## SCIENCE NOTES AND NEWS

### Award of Research Degree

The M. S. University of Baroda has awarded the Ph.D. Degree in Physics to Shri S. K. Shah for his thesis entitled "Studies in the Structure and Properties of Light Nuclei".

Andhra University has awarded the Ph.D. Degree in Geo-Physics to Shri A. R. Subramaniam for his thesis entitled "Some Studies of Aridity and Droughts in the Dry Climatic Zones of India".

Annamalai University has awarded the Ph.D. Degree in Chemistry to Kumari N. Padma for her thesis entitled "Preparation of Some Substituted 4-Piperidinols and a Study of Their Conformation"; and to Shri K. Aparajitan for his thesis entitled "Effects of Intramolecular Forces on Dipole Moments and U.V. Spectra".

### G. J. Watumull Memorial Awards

Nominations are now being received for the 1964 Watumull Memorial Awards, each of Rs. 5,000 or \$ 1,000 open to nationals of India who shall have distinguished themselves in some way by outstanding original research or service in any of the following categories that came to a successful conclusion during the past two years. The categories are divided into sciences, humanities and social sciences and 10 annual awards are distributed amongst these 3 categories. The nominations will close on December 31, 1963. All information and nomination forms may be obtained from the Watumull Foundation, 14, Talkatora Road, New Delhi.

The Watumull Foundation was founded in Honolulu, Hawaii, by Mr. Gobindram J. Watumull and these awards are given in his memory.

### Congress in Honour of Archimedes

Between April 12 and 16, 1961, there took place in Syracuse, Italy, a Congress to celebrate the memory of Archimedes, who was born in that city in 287 B.C. and killed there in 212 B.C. by a Roman soldier. There were lectures and symposia to mark the occasion. 128 mathematicians, physicists and engineers from various countries, including one from India, participated in the Congress.

Prof. Paul Montel of the French Academy of Science in his inaugural paper (read by Prof. Marie Charpentier of the University of Rennes) pointed out that the discoveries of Archimedes

arose from his imagination and intuition centuries ahead of his own time, and became a nucleus of theories which were not developed until much later. Archimedes could not make use of either algebra or differential or integral calculus, yet his works belong precisely to these branches of mathematics.

The delegates to the Congress saw the historic monument of Archimedes in the city. The great mathematician and inventor holds a concave mirror while on the monument the following words may be read:

"Invento speculo naves romanas incendit".—  
(*Scripta Mathematica*, March 1963.)

### The Indian Pharmaceutical Congress Association

The Fifteenth Session of the Indian Pharmaceutical Congress will be held during December 28-30, 1963, at Pilani, Rajasthan. Those who wish to attend the Session, or read papers, should contact either Hon. General Secretary, Indian Pharmaceutical Association, 213-219, Frere Road, Bharati Bhavan (3rd Floor), Bombay-1, or Hon. General Secretary, Indian Pharmaceutical Congress Association, 18, Convent Road, Calcutta-14.

### Lyman-Alpha Detector

Ion chambers have been used extensively in rocket flights to determine the intensity of the hydrogen Lyman-alpha line, 1215.7 Å, radiated from the sun, stars, and the earth's albedo. These detectors are characterized by a definite onset of sensitivity determined by the ionization potential of the gas and, in general, by a rather sharp cut-off in sensitivity determined by the transmissions limit of the window.

The most commonly used ion chambers for the detection of Ly- $\alpha$  are filled with nitric oxide or carbon disulphide gas, and sealed with lithium fluoride windows. This provides band-passes of 1050-1350 Å and 1050-1240 Å respectively for NO and CS<sub>2</sub> ion chambers. But both NO and CS<sub>2</sub> show a relatively constant (80-95%) photoionization yield to wavelengths shorter than 1215.7 Å.

The ideal Ly- $\alpha$  detector should have a very high photoionization yield at 1215.7 Å and a low yield at all other wavelengths. J. A. R. Samson and D. Golomb describe a method by which photoionization yield of a gas system is zero on the long wavelength side of 1240 Å,

85% for 1215.7 Å, and then decreases rapidly to zero at 1116 Å.

The principle of the method is to have two ionization chambers each filled with a gas whose ionization potentials differ slightly but have similar photoionization yields; then by subtracting their respective outputs the system should be sensitive only to the spectral region lying between the two I.P.'s. This is easily achieved by connecting the outputs of the two I.C.'s in parallel and by making the collector plate voltage of one I.C. positive and the other negative. Since the positive ion and electron currents are, in general, equal, the resultant output is equal to the difference in response between the two I.C.'s.

In practice it is difficult to find two gases with identical photoionization yields. However, by applying a sufficiently high voltage to the I.C. with the smaller photoionization yield the output can be increased by secondary ionization to the point where the effective photoionization yields of the two I.C.'s are equal at one wavelength and similar elsewhere.

Samson and Golomb find that to isolate Ly- $\alpha$  region carbon disulphide and bromoethane to be the most suitable choice. Further, lithium fluoride window and an oxygen filter make the detection system extremely selective to Ly- $\alpha$ . (*Rev. Sc. Inst.*, 1963, 34, 441.)

### Britain's First University Reactor

The Scottish research reactor, situated at East Kilbride, near Glasgow, has now become critical. It is the first University reactor to be commissioned in Britain and will be used jointly by the four Scottish universities—St. Andrews, Glasgow, Edinburgh, and Aberdeen—the Royal College of Science and Technology in Glasgow, and Queen's University, Belfast (Northern Ireland). The reactor and its associated buildings will cost a total of £ 255,000, met by a grant from the Department of Scientific and Industrial Research.

Courses are planned in nuclear engineering, reactor physics, radio-chemistry, health physics, uses of isotopes, and related subjects. It is expected that the research features of the reactor and the centre in general will be used by workers in a number of fields, including physics, chemistry, engineering, medicine and biology.

### Role of Non-metallic Reactor Fuels

The significant contribution that the use of non-metallic reactor fuels could make to the production of competitive nuclear power was outlined by the IAEA Director-General

Dr. Sigvard Eklund in his opening address to the Agency's Conference on New Nuclear Materials Technology in Prague on July 1, 1963.

Dr. Eklund noted that the recent experiences of the operation of nuclear power stations had shown that the working temperatures, burn-ups, load factors and lifetimes of the plants were greater than anticipated, and these had led to the growth of cautious optimism over the future role of nuclear power. In the established reactor types, however, temperature limitations of the fuels or of the cladding materials imposed a limitation on operating temperatures and net plant efficiencies. For example, in Magnox cladding (*i.e.*, the type of cladding adopted for natural uranium power reactors in Britain and France) the steam temperature was limited to 400° C., and the net plant efficiency in both Magnox reactors and light water reactors was about 30%.

Uranium oxide fuel with stainless steel cladding, on the other hand, would emit steam temperatures of about 480° C. With uranium carbide ceramic fuel dispersed in graphite one could obtain a steam temperature of 540° C. which would give a net station efficiency of about 35%.

Another advantage of ceramic fuels, Dr. Eklund said, was the possibility of achieving higher fuel burn-ups, due to the better temperature and radiation stability of such fuels. This would permit better utilization of fuel and less frequent refuelling. All this, he said, showed that non-metallic fuel elements were very promising and could contribute significantly to the realization of the goal of competitive nuclear power.—(*International Atomic Energy Agency News*.)

### Ultrasonic Thermometers for Low Temperatures

The National Bureau of Standards' *Technical News Bulletin* reports that the ultrasonic thermometer has been refined at the Bureau to the point where temperature measurements in the range 2-20° K. can be made with great accuracy and precision. Based on the determination of the speed of sound in helium gas, the ultrasonic thermometer is expected to establish an absolute temperature scale in the region 4-14° K., and to provide the basis for the calibration of germanium resistance thermometers. This thermometer eliminates the troublesome corrections required with gas thermometry and the need for precise volume and pressure determinations.

Accurate measurement of the speed of sound provides a means of determining absolute tem-

peratures as the speed in an ideal gas is proportional to the square root of the temperature. In practice, of course, a real gas is used, and considerations must be made of the effects of pressure. With the ultrasonic thermometer, the speed is determined at several pressures sufficiently low that a plot of speed *versus* pressure is linear and can be extrapolated to zero pressure. This procedure eliminates the need for pressure corrections and gives the speed in an ideal gas.

Measurements to date with the ultrasonic thermometer indicate a reproducibility of  $\pm .002^\circ$  at  $2^\circ \text{K.}$  and  $\pm .007^\circ$  at  $20^\circ \text{K.}$ , and close agreement at these temperatures with determinations made by other techniques. As the ultrasonic thermometer in itself is not conveniently useful for routine temperature measurements, a parallel programme in low temperature measurements with germanium resistors is also under way at the Bureau. It is through these secondary devices that the scale established with the ultrasonic thermometer will be used in general applications.—(Nat. Bur. Std. Technical Bulletin.)

#### Strontium-90 in Soils

The question of an increase of radioactivity through nuclear explosions is of great importance and concern, and has been the subject of investigation by many bodies in different countries. Suitable techniques of sampling and measurements have had to be developed and checked in order to obtain data sufficiently reliable for comparison of different localities at different times, and determinations of strontium-90 have attracted a good deal of attention. It is presumed that strontium-90 is produced in an atomic cloud as the oxide and that after an explosion over water or carbonate rock or at a high altitude the oxide would be converted in the atmosphere to the carbonate. At the low concentrations concerned this means that the fall-out would be largely water soluble. On the other hand, detonations over silicate-soil, as in the Nevada tests, would lead to a fraction of the strontium-90 being incorporated as insoluble silicates in the cloud. Both rain and soil samples have been studied. In the New York City area, there has been about ten times as much soluble as insoluble strontium-90. The amount of strontium-90 held by the soil will obviously depend on such factors as vegetation, rainfall, run-off and soil characteristics because most of the fission-product debris is brought down in rain or snow rather than as dry fall-out. The soil colloids have cation exchange properties, so that

the strontium-90 is absorbed in the surface layers and vertical movement is slow; on average, more than 90% is held in the top six inches. As a result of the nuclear tests in 1958, the deposit in the New York City area reached a maximum of about 70 mc./mi.<sup>2</sup> in 1961. This study, from the Lamont Geological Observatory, is described in the *Annals of the New York Academy of Sciences* (93, Art. 8).

#### Interference Fringes Produced by Two Independent Ruby Maser Beams

Optical interference effects are normally observed only with photons in coherent superposition states. Such states can be brought about with the help of beam splitters or induced optical transitions. However, transient interference effects have been demonstrated with two completely independent microwave beams (Hull, G. F., *Amer. J. Phys.*, 1949, 17, 559). Such effects, which are analogous to optical beats from incoherent sources, are understandable in classical terms, for the amplitude and phase of each beam remains constant for a time short compared with the reciprocal frequency spread,  $1/\Delta\nu$  (the coherence time). While it is true that in this case the ensemble average of the radiation intensity at different space points gives no indication of interference, the ensemble average is not relevant to any one short-time observation.

Interference effects ought to be observable also with two independent light beams, provided: (a) the photons in the two beams are not in orthogonal spin states; (b) the observation is made in a time shorter than the reciprocal total frequency spread,  $1/\Delta\nu$ , of the two beams, so that all the received photons may be regarded as falling into the same cell of phase space; (c) the mean number of photons received on a coherence area in a coherence time (see Mandel and Wolf, *Proc. Phys. Soc.*, 1962, 80, 894), that is, the mean occupation number of each cell of phase space—or the photon degeneracy parameter,  $\delta$ —is much greater than 1.

It is known that for light from typical thermal sources  $\delta$  is always much less than unity and reaches the value 1 only when the source temperature approaches  $10^5^\circ \text{K.}$  On the other hand,  $\delta$  is usually very large for optical maser beams, and this suggests the use of masers for the experiment.

Mandel and Magyar report in *Nature*, April 20, 1963, observation of transient interference fringes produced by the superposition of two independent beams of ruby maser light. The photograph obtained in a 40 nsec. exposure

shows distinct interference fringes obtained by the superposition of the two independent ruby maser light beams. As with microwaves, these interference effects are describable in completely classical terms.—(*Nature*, 1963, 198, 256.)

#### Radio Spectrum of SH-Radical

The presence of diatomic molecules in interstellar gas can now be detected by radio-telescope techniques. However, such detection and identification of the molecules require a prior knowledge of their characteristic radio spectrum. The likely diatomic radicals present in interstellar gas are OH, CH, SiH and SH which because of the  $\Lambda$ -type doublet structure of their ground states, possess electric dipole radio spectra of exceptional intensity. Because of the chemical instability of these radicals under laboratory conditions, measurements of their radio spectra are difficult and so far have been successful only for the relatively long-lived OH-radical.

With the recently discovered method by C. C. McDonald of continuous production of SH-radicals in a low-pressure gas, it has become possible to measure the  $\Lambda$ -type doubling spectrum of SH to high precision using the method of paramagnetic resonance absorption. By subjecting the gas sample to a magnetic field, one can shift the low frequency  $\Lambda$ -type doubling transitions to a conveniently high microwave band, where they may be measured with maximum sensitivity.

SH-radicals were generated by adding hydrogen sulphide to the products of an electric discharge in hydrogen gas. The mixing was done at the centre of a quartz absorption cell which lined the microwave cavity of an  $x$ -band superheterodyne paramagnetic resonance spectrometer. Absorption signals were observable at total pressures that ranged from several millimetres down to 0.1 mm. of mercury. The signal intensities depended critically on the relative flow rates of  $H_2$  and  $H_2S$ , the best mixing being that which reduced the atomic hydrogen concentration to zero (as judged by the intensity of the hydrogen resonance spectrum).

The PMR spectrum of free SH-radicals at microwave frequency 9216 Mc./sec. showed two groups of lines at the  $\Lambda$ -type doubling interval. Each group contains three hyperfine structure doublets and is characteristic of the Zeeman spectrum of SH in its ground state

$\pi_{3/2}$   $J=2/3$  level. The frequencies of the two strong ( $\Delta F=0$ ) lines which will serve to identify interstellar SH are:

$$\nu_1 = 111.26 \pm 0.10 \text{ Mc/sec. } (F=1 \rightarrow F=1), \text{ and}$$

$$\nu^2 = 111.58 \pm 0.10 \text{ Mc/sec. } (F=2 \rightarrow F=2). \text{ (Phys. Rev. Letters, 15 May 1963, 10, 443.)}$$

#### Velocity of Light in Terms of Primary Atomic Constants

The discovery of atomic clocks and optical masers has stimulated the setting up of an interferometric device for the measurement of the velocity of light in terms of primary atomic constants. The construction of an apparatus for carrying out such a measurement has been under way at the Massachusetts Institute of Technology since 1956, and the assembly has now been put into operation. Initial experiments have shown that the proper order of magnitude of  $c$  has been obtained. In a paper contributed to the *Journal of Applied Optics* (1963, 2, 481) G. W. Stroke describes the working of the principal components of the apparatus and some new features involved in the determination of  $c$ .

The method is essentially based on the equation,  $c = f\lambda_f$ , where  $f$  is the frequency of an electromagnetic radiation, and  $\lambda_f$  is the free-space wavelength at this frequency. With atomic clocks as the source of radiation,  $f$  is very conveniently obtained in the microwave region. In the M.I.T. assembly, for example, a Cs-133 atomic clock forms the radiation source giving its well-known microwave frequency ( $f$ ), 9192.632 Mc./sec. The microwave resonance cavity consists of a silver plated, optically polished fused quartz cylinder in which a perfect smooth piston is made to move continuously by means of a hydraulic device. In the experiment the distance between resonance positions of the piston, (the so-called guide-wavelength  $\lambda_g'$ , is measured in terms of a standard optical wavelength  $\lambda$ . This is supplied by an Hg-198 optical maser, and the measurement of  $\lambda_g'$  in terms of  $\lambda$  (vacuum) is carried out with the help of a photoelectric interferometer. For the computation of  $c$ , the free-space wavelength  $\lambda_f$  is obtained from the guide wavelength  $\lambda_g'$  by applying Maxwell's corrections when we get  $\lambda_f = [(r/\pi D)^2 + (1/\lambda_g')^2]^{1/2}$ , where  $D$  is the diameter of the cavity, and  $r = 3.832$ , a root of a Bessel function. (*Applied Optics*, 1963, 2, 481.)

481-63. Printed at The Bangalore Press, Bangalore City, by T. K. Balakrishnan, Superintendent, and Published by S. R. S. Sastry, for the Current Science Association, Bangalore.

All material intended for publication and books for review should be addressed to the Editor, *Current Science*, Raman Research Institute, Bangalore-6.

Business correspondence, remittances, subscriptions, advertisements, exchange journals, etc., should be addressed to the Manager, Current Science Association, Bangalore-6.

Subscription Rates: India: Rs. 12-00. Foreign: Rs. 16-00; £ 1-4-0; \$ 4.00.



# THE GREEN COLOUR OF VEGETATION

SIR C. V. RAMAN

**T**HE blue of the sky and the green of vegetation are the colours exhibited by the face of nature with which we are all most familiar, one due to the atmosphere of the earth lit up by the rays of the sun and the other to the leaves of plants growing under the beneficent influence of those same rays. Like the colours of the sky, the colours of vegetation show a great range of variation alike in respect of their luminosity and their hue. They are of the deepest interest to us, for they are the symbols of life on the surface of our planet without which it would be a dead world. Quite naturally, therefore, the origin of those colours might well be expected to be a thoroughly understood subject. Remarkably enough, this is not so and it might justly be said that the reason why grass looks green to us is far from being familiar knowledge.

Even the thinnest of leaves when held up in sunlight does not permit of the sun's disk being seen through it. In other words, the incident light is completely diffused or scattered besides suffering absorption within the material. It is very commonly the case that the upper and lower surfaces of a leaf present a very different appearance. The former exhibit in diffuse daylight a deeper colour and are also smoother. In consequence, when held at the proper angle to a beam of light incident on it, there is an observable reflection or glitter at the surface. On the other hand, the colour of the lower surface appears diluted by admixture with white light and by reason of its roughness, the regular reflection by the surface is weakened and may indeed not be noticeable at all. In the circumstances stated above, we have two distinct and alternative methods of studying the colour of green leaves. The first is to observe the *upper* surface of the

leaf holding it towards the light in such position and viewing it at such an angle that the surface reflection or glitter is unobservable and only the light emerging from the interior of the leaf is seen. The second method is to observe the light which emerges *through* the leaf when it is held up against the source of light. In the latter case, the slit of the observing spectroscope may be brought up close to the leaf. It then makes no difference which side of the leaf faces the source of light. In either case, it is desirable to use a powerful source of illumination.

It has long been known that the pigments universally present in green leaves are of two sorts and their chemical constitution has been ascertained by appropriate methods of investigation. They are respectively the carotenoids and the chlorophylls. When sunlight falls upon a leaf and before it can emerge again from its interior, it suffers both diffusion and absorption. It is the remnant that survives these processes which we perceive, though it should not be forgotten that in many cases, reflection and diffusion at the exterior surfaces of leaves also play an important role in determining their appearance to an observer. If we lay aside the latter complication, we may say that the perceived colour is determined principally by the extinction of the sun's rays in their passage through the material of the leaf produced by the pigments referred to above. It is well known also that the carotenoids exercise a powerful absorption of the blue and violet regions of the spectrum. Such absorption is amply sufficient to account for the fact that very little of the wavelength range between 400 m $\mu$  and 500 m $\mu$  gets through a green leaf, as may be readily

verified by holding it up against the bright sky and viewing the light which filters through with a pocket spectroscope. Even with tender leaves which exhibit a greenish-yellow hue, the blue and violet of the spectrum come through only feebly, while in the case of the thicker and more mature leaves which appear of a full green colour, the extinction of the violet and blue is complete and extends also into the green up to  $520\text{ m}\mu$ . The two species of chlorophyll respectively labelled as (a) and (b) which are present in green leaves exhibit a powerful absorption in the vicinity of the red end of the spectrum, the peak of chlorophyll (a), according to the observations which have been made with the material in an ether solution, appearing at about  $660\text{ m}\mu$  and that of chlorophyll (b) at about  $640\text{ m}\mu$ . By holding up a green leaf against direct sunlight, and viewing the light emerging through it with a pocket spectroscope, it is possible to observe the absorption bands due to the chlorophylls appearing in the extreme red.

When we seek to understand or explain the colour of green leaves observed in these circumstances, it is necessary to remember that the luminous efficiency of monochromatic light varies enormously over the range of the visible spectrum. It is very small near the violet end of the spectrum, rises progressively and reaches a maximum at about  $560\text{ m}\mu$  and then drops down again at longer wavelengths. At  $640\text{ m}\mu$ , it is only about 20% of its value at  $560\text{ m}\mu$ , while at  $660\text{ m}\mu$ , it is only about 10% and at  $680\text{ m}\mu$ , it is very small. It is clear from these figures that the major chlorophyll absorptions appear in a region of which the luminous efficiency is already small. It follows that they could have no great influence on the visually perceived effect of the light that comes through, either in respect of the luminosity or in respect of its hue. It is known also that chlorophylls have a power-

ful absorption in the wavelength range between  $400\text{ m}\mu$  and  $500\text{ m}\mu$ . But this is the range in which the absorption by the carotenoids is also effective. The effect of the chlorophylls would therefore merge into it and need not be separately considered in the present context.

Thus, the observed colour of a leaf would be determined by its spectroscopic behaviour in the wavelength range between  $500\text{ m}\mu$  and  $640\text{ m}\mu$  in which region neither the carotenoids nor the chlorophylls have any major absorptive effects. What the colour exhibited to our vision by this range of wavelengths would be—in the absence of any specified absorption within that range—can be readily ascertained in a variety of ways. We may, for instance, simply view the sky through a colour filter which cuts out the whole of the spectrum up to  $520\text{ m}\mu$  and lets through all greater wavelengths. The light transmitted by such a filter appears of a golden-yellow hue. There are several alternative procedures which yield the same observable result, *viz.*, a golden-yellow colour. For example, we may use the petals of any flower which exhibits that hue and find that the light which filters through it has the same or nearly the same spectral composition. Many croton leaves exhibit (at least in some areas) a golden-yellow hue. Likewise, green leaves which have passed the stage of maturity and are about to drop off the tree usually exhibit a golden-yellow colour. Any of these cases can serve as a standard of comparison with the spectrum of green leaves in various stages of maturity.

When such comparisons are made, a surprising result emerges, *viz.*, that the spectrum of the light emerging through a green leaf bears a close resemblance to that observed in the transmission through a flower or a leaf exhibiting a golden-yellow hue. Indeed, at first sight, it is not easy to discover what the differences in spectral

composition are which give rise to the observed differences in the perceived colour. A critical examination of the transmission spectra of leaves in various stages of maturity however discloses that in the

the green and orange-red sectors of the spectrum which lie on either side then appearing well separated from each other. As we proceed from stage to stage in the development of the leaf towards maturity,

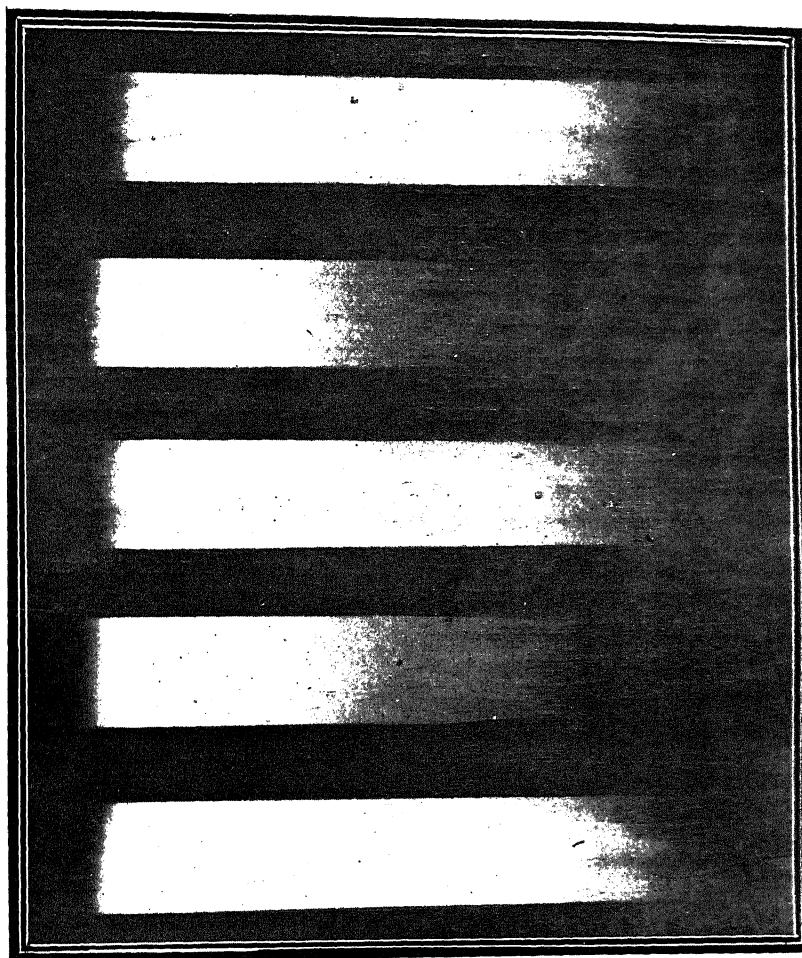


FIG. 1. Spectroscopic comparison of green leaves and a yellow colour-filter.  
(a), (c) and (e), Green leaves; (b) and (d), Colour-filter.

spectrum of the green leaf, the yellow sector of the spectrum between  $570 m\mu$  and  $590 m\mu$  is weakened. This weakening is just discernible with immature leaves which exhibit a greenish-yellow hue. It is easily seen in the case of mature leaves which exhibit a bright green colour. Leaves whose colour is a dark green show the absorption band between  $570 m\mu$  and  $590 m\mu$  conspicuously,

the total quantity of light which finds its way through the leaf also progressively diminishes. Both the green and the orange-red sectors of the spectrum, however, continue to be visible with comparable intensities. But the intensity of the orange-red sectors relatively to that of the green sector shows an observable and progressive diminution.

From these observations, it becomes clear that the colour differences observed between a green leaf and a golden-yellow flower are the result of the absorption of the yellow sector of the spectrum between  $570\text{ m}\mu$  and  $590\text{ m}\mu$  in the green leaf. As this absorption progressively increases, the colour changes from a greenish-yellow to a bright green and finally to a dark green. Further, since the orange-red sector of the spectrum is conspicuously visible even in the case of mature green leaves whose colour does not exhibit the slightest hint of any yellowish tinge, we are obliged to conclude that as the yellow sector between  $570\text{ m}\mu$  and  $590\text{ m}\mu$  which is the connecting link between the green and the orange-red sector is weakened, the effect of the orange-red is masked or suppressed, in other words, prevented from entering into the range of perception, by reason of the presence of the more luminous green sector.

Owing to the non-uniformity of the photographic sensitivity of the commercially available panchromatic films in the region of the spectrum with which we are here concerned, it is not easy to obtain and present an objective demonstration of the facts of observation described above in the form of recorded spectra. After some discouraging failures, however, a fair measure of success has been achieved using the special "AGFA Raman plates" which have been developed by a well-known firm of manufacturers.

Five spectrograms appear in Fig. 1 here reproduced. Of these, the second and the fourth, Figs. 1 (b) and (d), are the spectra of the light source employed when covered with a golden-yellow filter. In these pictures, the left half of the spectrum exhibiting the red and orange sectors appears much brighter than the right half which is the green sector. This is due to the difference in photographic sensitivity for these

regions. It does not, however, prevent the effect under consideration, *viz.*, the absorption in the yellow by the green leaves being exhibited in three other spectrograms, *viz.*, Figs. 1 (a), (c) and (e). They were recorded with three croton leaves, which were respectively a very dark green, a bright green and a greenish-yellow in colour. Figure 1 (a) exhibits the absorption band in the yellow quite clearly. But it is much less clear in Fig. 1 (c) and can scarcely be made out in Fig. 1 (e).

Figure 1 also exhibits the other effects mentioned. In all the three cases studied, the red and the orange parts of the spectrum come through and their intensities are seen to be comparable with those of the green sector. We should, however, take note of the difference in photographic sensitivities for these regions. When due allowance is made for this, it is seen that the red-orange sector is weaker relatively to the green in the darker-coloured leaves.

We may sum up the results of the study by the statement that it is the absorption of the yellow of the spectrum and not the absorption of the red that is responsible for the observed green colour of leaves. That the absorption band in the yellow is not noticeable in the case of leaves which have turned yellow before dropping off is an indication that chlorophyll is responsible for its presence, either by itself or in association with the carotenoid pigments.

The extraordinary role played by the yellow sector of the spectrum in the case of the green leaves does not stand by itself. Indeed, in a forthcoming memoir by the author which will shortly appear in the *Proceedings of the Indian Academy of Sciences*, it is shown to be a very general feature. That the masking of the weaker by a stronger sensation is also a general feature has been recorded in that memoir.

SOME OBSERVATIONS ON THE CYTOLOGY IN THE GENUS *TEPHROSIA* PERS.

J. VENKATESWARLU AND C. KAMESWARA RAO

Department of Botany, Andhra University, Waltair

THE genus *Tephrosia* Pers. belongs to the tribe Galegeae of the subfamily Papilionatae. *T. purpurea* Pers. is a polymorphic species as observed in the populations growing at Waltair, a feature also shown in populations of this species in most other countries in which it occurs.\* Among the populations of this species growing at Waltair some are procumbent and show gigas vegetative features while the predominant numbers of plants are erect with smaller-sized vegetative and floral parts and pods (Figs. 1 to 6 and Table I). Plants of the

TABLE I

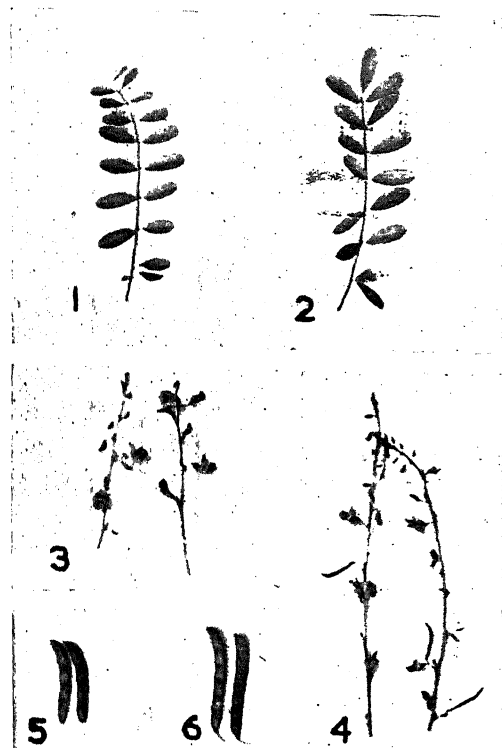
Showing measurements of some vegetative and floral plants and pods in *T. purpurea* and *T. purpurea* (2) averaged from 15 observations each

Character	<i>T. purpurea</i>	<i>T. purpurea</i> (2)
Stipule length (cm.)	.. 0.10	0.34
Petiole length (cm.)	.. 0.10	0.15
Number of leaflets (range)	.. 9-15	9-17
Length of the leaflets (range) (cm.)	.. 1.1-1.5	1.8-2.3
Breadth of the leaflets (range) (cm.)	.. 0.5-0.8	0.6-1.0
Length of the guard cell ( $\mu$ )	.. 18.30	20.76
Length of the Palisade cell ( $\mu$ )	.. 17.50	28.20
Breadth of the Palisade cell ( $\mu$ )	.. 5.90	8.10
Length of the pedicel (cm.)	.. 0.41	0.50
Length of the standard (cm.)	.. 0.82	0.93
Length of the ovary (cm.)	.. 0.50	0.65
Length of the pod (cm.)	.. 3.50	4.30
Pollen diameter ( $\mu$ )	.. 30.00	32.00

former category are referred to, hereafter, as *T. purpurea* (2). Observations presented in the following account relate to these two types of plants, *T. hirta* Ham., *T. maxima* Pers., and *T. pumila* Pers.

Ramanathan<sup>1</sup> reported a chromosome number of  $2n = 24$  in *T. purpurea* while Tandon and Malik<sup>2</sup> observed  $n = 11$  in the same species. Frahm-Leliveld<sup>3</sup> recorded  $2n = 22$  and Malik<sup>4</sup> found  $n = 11$  in *T. villosa* (*T. hirta*). Ramanathan<sup>5</sup> observed  $2n = 24$  also in *T. purpurea* var. *marima* (*T. maxima*) and *T. purpurea* var. *pumila* (*T. pumila*). All the materials studied by us showed regularly formation of 11 bivalents

during the course of meiosis. Thus the present account records chromosome numbers different from those reported by Ramanathan<sup>1,2</sup> for *T. purpurea*, *T. maxima* and *T. pumila*. Besides the record of  $2n = 24$  in the three species noted above, Tandon and Malik<sup>2</sup> and Malik<sup>4</sup> reported naturally occurring allotetraploid races in *T. purpurea* and *T. hirta* respectively. Wood<sup>6</sup> found  $2n = 22$  in *T. consattii*. The material revealed also the presence of B chromosomes whose number varied from 0 to 2. Thus there seem to be different karyological races in the species discussed above.



FIGS. 1-6. Figs. 1, 3 and 5. Leaf, inflorescences and mature pods of *T. purpurea*. Figs. 2, 4 and 6. The same of *T. purpurea* (2). (All about 1/3 natural size.)

The pachytene chromosomes in all the materials studied here are of the highly differentiated type showing large intercalary heterochromatic segments and blocks of heterochromatin on either side of the centro-

\* We thank the Director, Royal Botanic Gardens, Kew, England, for a personal communication in this respect and for naming the plants in the present study.

TABLE II

Showing details of morphological features of the nucleolus-organizing chromosomes in the five materials under study at pachytene (from 10 observations in each).

Name of the plant		Total length ( $\mu$ )	Length of the long arm ( $\mu$ )	Heterochromatin in long arm ( $\mu$ )	Length of the short arm ( $\mu$ )	Heterochromatin in short arm ( $\mu$ )	Arm ratio	Total heterochromatin
							S.A. L.A.	total length
<i>T. purpurea</i>	..	46.59	34.09	25.45	10.68	9.77	0.313	0.75
<i>T. purpurea</i> (2)	..	48.86	38.90	20.40	8.19	7.72	0.210	0.58
<i>T. hirta</i>	..	28.18	23.77	12.27	3.09	3.09	0.131	0.54
<i>T. maxima</i>	..	30.46	22.50	4.36	6.36	4.31	0.282	0.27
<i>T. pumila</i>	..	43.87	32.27	12.27	10.00	8.63	0.309	0.48

TABLE III

Showing chiasma frequency per nucleus, terminalization coefficient and percentage of rod bivalents at diakinesis and metaphase I.

Name of the plant		Xma frequency per nucleus		Terminalization coefficient		Percentage of rod IIs	
		At Diakinesis	At Metaphase I	At Diakinesis	At Metaphase I	At Diakinesis	At Metaphase I
<i>T. purpurea</i>	..	20.80	15.40	0.463	0.744	15.30	61.30
<i>T. purpurea</i> (2)	..	18.75	13.82	0.380	0.629	33.34	75.20
<i>T. hirta</i>	..	20.29	..	0.686	..	23.05	..
<i>T. maxima</i>	..	18.34	13.08	0.535	0.835	40.50	64.93
<i>T. pumila</i>	..	24.36	..	0.545	..	10.50	..

meres. Most of the chromosomes at this stage show conspicuous telomeres.

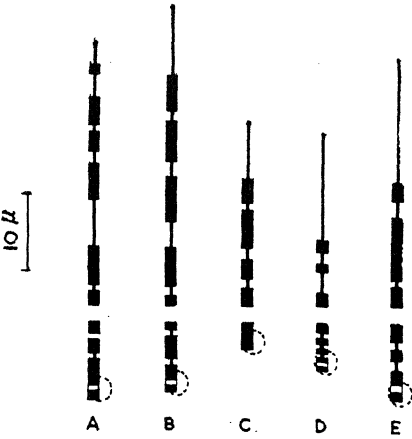


FIG. 7. Idiogram of the nucleolus-organizing chromosomes in (A) *T. purpurea*, (B) *T. purpurea* (2), (C) *T. hirta*, (D) *T. maxima* and (E) *T. pumila*, at pachytene. The centromere is shown as a gap and the nucleolus as a dotted circle. The unfilled region at the nucleolus is the secondary constriction. The heavy black blocks represent heterochromatin and the lines euchromatin. (The secondary constriction in *T. hirta* could not clearly be located except by way of its attachment to the nucleolus.)

At pachytene, only one nucleolus-organizing chromosome pair is seen in all the 4 species

and *T. purpurea* (2). The centromere is sub-terminal in position and the nucleolus-organizing body situated in the short arm is separated from the rest of the chromosome by a nearly terminal secondary constriction. Table II shows details of morphological features of the nucleolus-organizing chromosomes in the five materials studied here and Fig. 7 shows an idiogram based on the above analysis. The total lengths vary from 28.18  $\mu$  (*T. hirta*), to 48.86  $\mu$  [*T. purpurea* (2)] and the arm ratios from 0.131 (*T. hirta*) to 0.313 (*T. purpurea*). The most asymmetrical nucleolus-organizing chromosomes are those of *T. hirta* which are also the shortest. The whole of the short arm of the nucleolus-organizing chromosomes in this species is heterochromatic. Highest amount of deposition of heterochromatin in relation to total length of the chromosomes is found in *T. purpurea* (0.75) and lowest in *T. maxima* (0.27). In general, the short arms showed a predominant accumulation of heterochromatin.

Meiosis is regular in all the materials studied here. In *T. maxima*, however, formation of univalents at an average frequency of 2.66 univalents per nucleus is observed. Fifty nuclei at diakinesis in each of the five materials and 30 nuclei each in *T. purpurea*, *T. purpurea* (2) and *T. maxima* at metaphase I were analyzed

in respect of chiasma frequency per nucleus, terminalization coefficient and percentage of rod bivalents (Table III).

A Junior Research Fellowship awarded to the junior author by the Council of Scientific and Industrial Research is gratefully acknowledged.

#### THE ANTARCTIC KRILL, THE STAPLE FOOD OF THE WHALES\*

WE have accounts in these series (*Discovery Rep.*, 1961, 31, 327-483; and *Ibid.*, 1962, 33, 1-45) which pointed out the economic importance of the whale fishery and how a knowledge of the life-history and movements of the whales is essential for a rational exploitation of the fishery. The present paper stresses the importance of the krill, *Euphausia superba* Dana, the staple food of the Antarctic whales. A three-dimensional picture is presented—in duration of time (data collected over a period of 20 years), extent of the horizontal distribution (practically the entire Antarctic area) and vertical (depth) distribution,—besides covering all its developmental stages from egg to the adult stage and of the various environmental factors—currents, pack ice, temperature, its food, predators, etc.—affecting the krill.

The report is a bulky one packed with valuable and interesting data covering almost every aspect of this organism; hence, in a review of this nature, one has to satisfy oneself with a brief reference to some of the most striking and salient points, inviting the attention of the reader to the original.

The eggs hatch at great depths and the larvae, Nauplii, Metanauplii and First Calyptopsis, rise to the surface and all the subsequent development up to Furcilia Six takes place in the surface layers. Diurnal vertical movements are limited, particularly seen in the larvae, confined to the surface layers only, become less pronounced as the krill reaches the adult form. The krill occurs in astronomical abundance; a conservative estimate places the figure at 38 million tons as being grazed down by the whales, in terms of numbers 47 million million, on an average per year calculated for the period 1933-1939. They occur in patches, some even 150 square miles in extent; patches do not appear to be affected by animal exclusion or pack ice. They occur in swarms which keep together. They feed voraciously on diatoms and the

1. Ramanathan. K., *Curr. Sci.*, 1950, **19**, 155.
2. Tandon, S. L. and Malik, C. P., *Oydon*, 1960, **14**(2), 127.
3. Frahm-Leliveld, J. A., *Euphytica*, 1953, **2**, 46.
4. Malik, C. P., *Genetica*, 1961, **32**, 170.
5. Ramanathan. K., *Curr. Sci.*, 1955, **24**, 17.
- \*6. Wood, C. E., *Rhodora*, 1949, 53.

\* Not seen in original.

quantity of diatoms that may have to be produced may well be imagined, which emphasizes the high organic productivity of the Antarctic waters. The rich vitamin A content of the liver of the whale is ultimately traceable to the diatoms *via* the krill. Spawning takes place in relatively shallow waters and the eggs are carried to deep waters by the sinking Weddell shelf water. The whale-markings suggest that feeding whales do not move entirely at random, but tend to travel against the surface drift that is carrying the whale food, the krill. Sex composition of krill swarms is more or less of equal numbers, male and female. The rate of growth of swarms is discussed. The great summer larval outburst in the western Weddell drift and the subsequent spread of larvae to the north and east in the surface stream are annual events. There is a striking massing of krill on the north-east side of South Georgia where the Weddell Sea surface drift is conspicuous. The east wind drift is an untapped source of whale food and contributes to the conservation of the population. The distribution and relative abundance of *E. superba* and *E. triacantha* are compared and the reason for the former's overwhelming dominance indicated. The mechanism which appears to maintain the krill population within the natural geographic limits is examined—the movement of the different water masses.

As the editor has remarked, the report is a comprehensive study of an important organism in relation to its environment and the reviewer doubts whether there is any other comparable account of such a magnitude dealing with any single pelagic organism of the sea. The methods adopted should be very useful to those engaged in similar research. The report is well written and profusely illustrated with charts and ends with a bibliography of over 700 references. It is a "monograph" which investigators on fishery problems would do well to study, particularly in India. The author, sponsors and the publishers are to be congratulated in bringing out this valuable addition to our knowledge which is sure to find a place in all libraries.

R. SUBRAHMANYAN,

\* *The Natural History and Geography of the Antarctic Krill*. (*Euphausia superba* Dana). By J. W. S. Marr. *Discovery Rep.* 32. (Issued by the National Institute of Oceanography, U.K., Cambridge University Press, London), 1962. Pp. 33-464. Price £ 10 net.

## RESPONSE OF MULBERRY SEEDS TO GIBBERELIC ACID TREATMENT

L. S. PRAHLADA RAO, T. PENNIDHANA RAO AND E. S. NARAYANAN

Central Sericultural Research Institute, Channarayana, Mysore State

PREVIOUS reports on the effect of Gibberellic acid on seeds of several plant species indicate, except in a few cases, an acceleration in germination<sup>1,2</sup> and elongation of the seedlings.<sup>1,2</sup> Reversal of the dwarfing effect caused by irradiation in seedlings by subsequent treatment of the seeds with Gibberellic acid has also been reported.<sup>3</sup> In mulberry, the published reports<sup>4-7</sup> are with reference to the effect of Gibberellic acid by the spray methods only. In the present investigations the effect of Gibberellic acid was tested on the seeds of *Morus indica* Linn. Aqueous solutions of the chemical were used in 10 ppm, 25 ppm, 50 ppm and 100 ppm concentrations. The B.D.H. sample of Gibberellic acid was used. The seeds were taken in batches of 200 for a constant weight. Two controls were maintained, one sown after soaking in water for 24 hrs. and the other in the dry state. The batches of the seeds to be treated were soaked in the solutions of the chemical of different concentrations for 24 hours with pre-soaking in water. The imbibition of the water as well as the chemical solution subsequently was recorded. The seeds were sown in wooden flats with sand, in-doors, where the average temperature and humidity were 28° C. and 67.37% respectively. The seed samples used were collected during the month of February 1963 and had been stored for a period of three months at the time of the treatment. The germination percentage was recorded at 24-hr. intervals for all the batches. At the time of transplanting after a growth period of 12 days, the length of the seedlings was scored (cf. Table I).

TABLE I  
Percentage of germination and average length of seedlings

No.	Treatment	No. of seeds sown	% of germination	Average length of seedlings (Average of 50)
1	GA 10 ppm	200	62	1.83"
2	" 25 "	200	77	1.96"
3	" 50 "	200	94	2.13"
4	" 100 "	200	86	1.55"
*5	Control I	200	34	1.51"
†6	" II	200	26	1.53"

\* Seeds soaked for 24 hrs. in water and sown.

† Seeds sown in the dry state.

From the observations recorded, the significant points indicated are, that (i) the treatment with Gibberellic acid at all concentrations has revealed an acceleration of germination (Fig. 1), (ii) a higher percentage of germination (Fig. 2) and (iii) increase in the length of

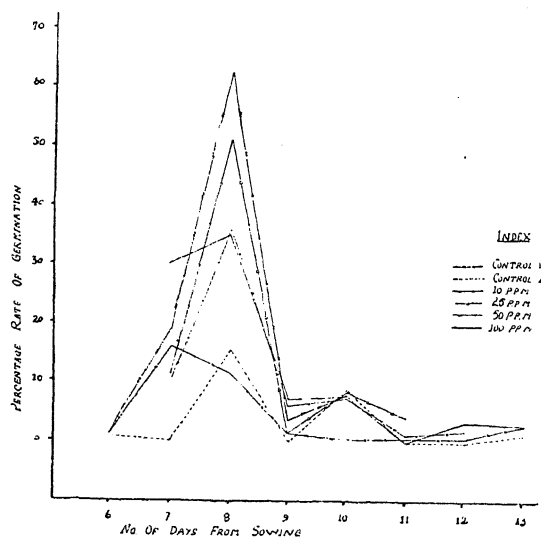


FIG. 1

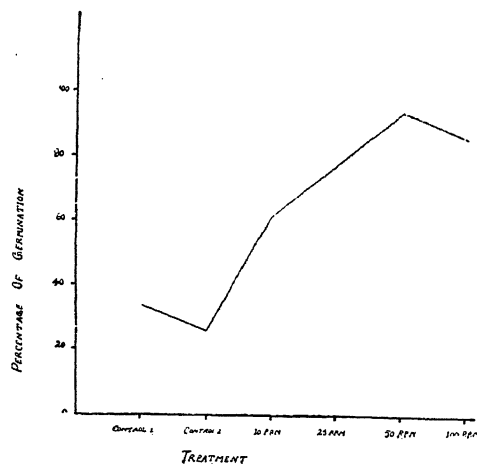


FIG. 2

the seedlings as compared to the controls (cf. Table I). The 50 ppm concentration was the most effective giving maximum values for all the factors cited above. A point of practi-



cal interest in this study has been that, treatment with Gibberellic acid has given maximum germination values even for seeds stored under ordinary conditions, as the results of the previous investigations on mulberry seed storage in this laboratory<sup>8</sup> had indicated considerable loss in viability with increasing periods of storage. In the previous investigations<sup>8</sup> the maximum percentage of germination was recorded for fresh seeds sown with pulp and very low values were obtained for stored seeds. In the present study, even the seeds stored for a period of three months have given the maximum germination value of 94% with the 50 ppm Gibberellic acid treatment. This is a pointer to the advantage of the Gibberellic acid treatment in getting better germination values with stored seeds. Another special point of note is that the response to Gibberellic acid treatment is more

significant in seed treatment as compared to the shoot-bud treatment by spray, the results of which are elaborated in another paper under communication.

1. *Gibberellic Acid*, Plant Protection Limited, Farnham Research Station, England.
2. Ikuma, H. and Thimann, K. V., *Plant Physiology*, 1960, 35 (5), 557.
3. Gaur, B. K. and Notani, N. K., *Internat. J. Radiat. Biol.*, 1960, 2 (3), 257.
- \*4. Takizawa, Y. and Kano, S., *Abstr. 2nd Meeting, Japan, Gib. Res. Ass.*, 1958, p. 78.
- \*5. — and —, *Abstr. 3rd Meeting, Japan, Gib. Res. Ass.*, 1960, 4.
- \*6. — and —, *Abstr. 4th Meeting, Japan, Gib. Res. Ass.*, 1961, 11.
- \*7. Pyl'Nov, I. V., *Bull. Acad. Sci., USSR*, 1961, 46.
8. Prahlada Rao, L. S., *C.S.B. Newsletter*, 1959, 4 (12), 1.

\* Not seen in original.

## ON THE REGULARITY OF THE TETRAHEDRA IN QUARTZ

ON the basis of extensive structural studies, it has been practically taken for granted that in quartz as well as in the other silica phases the  $\text{SiO}_4$  tetrahedra are strictly regular; that any of the observed small deviations from regularity was simply the result of experimental errors in the diffraction data. However, two recent refinements on  $\alpha$ -quartz, the first by Young and Post (YP) in 1962, and the second by Smith and Alexander (SA) in 1963,—have yielded bond data which seem to suggest a rethinking in this regard. While some of the bond data presented by them are consistent with the regular configuration, the deviations from regularity shown by others are large enough to be statistically significant, as for example :

S and A: Si—O 1.617 Å; 1.597 Å.  
 $\angle$  Si—O—Si 144.0°  
 Y and P: Si—O 1.611 Å; 1.603 Å.  
 $\angle$  Si—O—Si 143.9°

The existence of regular tetrahedra in quartz introduces relationships between the size of the

tetrahedra and the unit cell dimensions; and from the temperature dependence of the unit cell dimensions some definite conclusions can be drawn concerning the regularity of the tetrahedra at a number of temperatures.

Gordon S. Smith (*Acta Cryst.*, 1963, 16, 542) from analysis based on symmetry considerations has derived the conditions under which the  $\text{SiO}_4$  tetrahedra in quartz can be strictly regular. According to him for such a configuration the Si—O bond distance in  $\alpha$ -quartz must be  $[\sqrt{(3)a-c}]/2$ , and  $c/a$  must be  $< 3/2 [\sqrt{(3)}-1]$ ; in  $\beta$ -quartz the axial ratio must be  $(3/2) [\sqrt{(3)}-1]$ .

Comparison of his deductions with published data on lattice constants, shows that in the vicinity of room temperature regular  $\text{SiO}_4$  tetrahedra are not possible in  $\alpha$ -quartz, or in  $\beta$ -quartz. Hence the deviations from regularity reported by SA and YP in  $\alpha$ -quartz must be regarded as real. It is suggested that  $\alpha$ -quartz at 25° C. be considered to have two different types of Si—O bond lengths, namely,  $1.600 \pm 0.003$  Å, and  $1.614 \pm 0.003$  Å.

## LETTERS TO THE EDITOR

TYPE-N GRAVITATIONAL WAVES IN  
NON-EMPTY SPACE-TIME

In an earlier paper<sup>1</sup> the author has given three exact solutions of the Einstein-Rosen<sup>2</sup> cylindrically symmetric space-time corresponding to the field equations of Lichnerowicz's<sup>3</sup> total radiation. The solutions were interpreted as representing a fluid distribution of photons with null geodesics as world lines of flow. In a recent survey article on gravitational radiation theory Pirani,<sup>4</sup> while commenting on gravitational radiation in non-empty space-time, wrote '...it is natural to presume, for example, that a space-time with matter and a type N or type III Weyl tensor is pervaded by gravitational radiation'. The object of the present note is to show that in fact one of our total radiation solutions possesses Weyl tensor exactly of type N and therefore can be interpreted as representing gravitational radiation in non-empty space-time.

The Einstein-Rosen metric for cylindrically symmetric space-time can be expressed in polar co-ordinates as

$$ds^2 = e^{2\gamma-2\psi} (dt^2 - dr^2) - r^2 e^{-2\psi} d\phi^2 - e^{2\psi} dz^2 \quad (1)$$

where  $\gamma$  and  $\psi$  are functions of  $r$  and  $t$  only. In the earlier cited reference of the author it has been shown that with

$$\psi = 0, \quad \gamma = \gamma(r-t), \quad (2)$$

(1) represents a universe filled with total radiation. The space-time is not empty because

$$R_1^1 = -R_4^4 = R_1^4 = -R_4^1 = \frac{e^{-2\gamma}\gamma'}{r}. \quad (3)$$

Here and in what follows an over-head dash for  $\gamma$  represents a differentiation with respect to the argument  $(r-t)$ .

The only non-vanishing components of the Weyl curvature tensor for (1) with the values of  $\psi$  and  $\gamma$  given in (2) are

$$\begin{aligned} -\frac{S_{1212}}{r^2} &= -\frac{S_{1224}}{r^2} = -\frac{S_{2424}}{r^2} = S_{3131} = -S_{3134} \\ &= S_{3434} = \frac{\gamma'}{2r}. \end{aligned} \quad (4)$$

Now following Pirani's<sup>5</sup> scheme, the physical components of the Weyl curvature tensor given in (4) with the tetrad

$$\begin{aligned} \lambda_{(1)}^i &= (e^{-\gamma}, 0, 0, 0), \\ \lambda_{(2)}^i &= (0, 1/r, 0, 0), \\ \lambda_{(3)}^i &= (0, 0, 1, 0), \\ \lambda_{(4)}^i &= (0, 0, 0, e^{-\gamma}) \end{aligned}$$

can be written in the form

$$S_{AB} = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -\sigma & 0 & 0 & 0 & \sigma \\ 0 & 0 & \sigma & 0 & \sigma & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & \sigma & 0 & \sigma & 0 \\ 0 & \sigma & 0 & 0 & 0 & -\sigma \end{bmatrix} \quad (A, B = 1, \dots, 6)$$

where  $\sigma = -e^{-2\gamma}\gamma'/2r$ . Therefore the cylindrically symmetric space-time given by (1) and (2) has Weyl tensor of type N and represents gravitational radiation in non-empty space-time.

The author's grateful thanks are due to Prof. P. C. Vaidya for his help in the preparation of this note.

Dept. of Mathematics,  
Gujarat University,

J. KRISHNA RAO.

Ahmedabad-9, June 25, 1963.

1. Krishna Rao, J., To appear in *Proc. Nat. Inst. Sci., India*.
2. Einstein, A. and Rosen, N., *J. Franklin Inst.*, 1937, 223, 43.
3. Lichnerowicz, A., *Annali di Matematica pura ed applicata* (iv), 1960, 50, 450.
4. Pirani, F.A.E., *Recent Developments in General Relativity*, Pergamon Press, 1962, p. 103.
5. —, *Phys. Rev.*, 1957, 105, 1089.

ON THE GEOMETRY OF LORENZ  
CURVE OF CONCENTRATION FOR  
TRUNCATED EXPONENTIAL, PARETO  
AND LOGNORMAL DISTRIBUTIONS

It is known<sup>1</sup> that the point D where the tangent to the Lorenz Curve of a Lognormal distribution is parallel to the egalitarian line lies on the other diagonal of the unit square. M. P. Sastry<sup>2</sup> has proved that, in the case of an Exponential distribution, D is below the other diagonal; whereas, for a Pareto distribution, D is above the other diagonal. By consideration of limit situations, K. Nagabhushanam and M. P. Sastry<sup>3</sup> conjectured that the position of D will continue to be below or above the other diagonal of the unit square according as the original distribution is Exponential or Pareto even when the distribution is truncated at the right tail end. The object of the present note

is to prove these conjectures, and also to examine the nature of the corresponding geometry of the Lorenz Curve for a Lognormal distribution with its right tail end being truncated.

## 2. Exponential distribution :

$$dF(x) = c \cdot e^{-cx} dx, \quad c > 0, \quad 0 \leq x \leq \infty.$$

The sum of the co-ordinates of D ( $x_1, y_1$ ) works out to

$$\frac{1 - e^{-k}}{F(a)} + \frac{1}{k \cdot F(a)} [1 - e^{-k} - k e^{-k}]$$

where

$$F(a) = 1 - e^{-ac}, \quad K = 1 - \frac{ac e^{-ac}}{F(a)},$$

and  $a$  is the point of truncation. It is easy to see that there exists an  $a_0 > 0$ , such that, for  $a > a_0$ ,  $x_1 + y_1 < 1$ . How small  $a_0$  can be made depends on how effectively inequalities are used. But the point of interest is that in almost all practical cases of truncation,  $a$  is large enough for easily establishing that  $x_1 + y_1 < 1$ , i.e., D is below the other diagonal of the unit square.

## 3. Pareto distribution :

$$dF(x) = \alpha x_0^\alpha x^{-\alpha-1} dx, \quad \alpha > 1, \quad x \geq x_0.$$

When a Pareto distribution, truncated at the right tail end, is considered, the sum of the co-ordinates ( $x_1, y_1$ ) of the point D on the Lorenz Curve, where the tangent is parallel to the egalitarian line, is

$$\frac{1}{k} (1 - M^{-\alpha}) + \frac{1 - M^{1-\alpha}}{1 - \left(\frac{a}{x_0}\right)^{1-\alpha}},$$

where  $a (> x_0)$  is the point of truncation, and

$$k = 1 - \left(\frac{x_0}{a}\right)^\alpha,$$

and

$$M = \frac{1 - \left(\frac{a}{x_0}\right)^{\alpha-1}}{k \left(1 - \frac{1}{a}\right)}.$$

From this it can be established that  $x_1 + y_1 > 1$  which proves the conjecture that D continues to lie above the other diagonal of the unit square.

## 4. Lognormal distribution :

$$dF(x) = \frac{1}{2\pi\sigma x} \cdot e^{-(1/2\sigma^2)(\log x - \mu)^2} dx,$$

$$\mu > 0, \quad \sigma > 0, \quad 0 \leq x \leq \infty.$$

In this case it is not possible to conjecture straight-away by consideration of the limiting

situation how the point D will behave when the right tail of the Lognormal distribution is truncated. The author has carried out numerical work which has led him to the following conjecture :

D will now be situated above the other diagonal but will move to it as the point of truncation moves to infinity.

My thanks are due to Prof. K. Nagabhushanam for the help and guidance in the preparation of this paper.

Andhra University,  
Waltair, June 17, 1963.

P. SAMBAMURTY.

1. Aitchison, J. and Brown, J. A. C., *The Lognormal Distribution*, University of Cambridge.
2. Sastry, M. P., *Unpublished Ph.D. Thesis*, Andhra University, Waltair, 1960.
3. Nagabhushanam, K. and Sastry, M. P., *A Study of Rural Income Distribution*, Second Indian Econometric Conference, Waltair, June 1961.

## ON THE MIXING RATIOS ( $M_1-E_2$ ) IN SOME EVEN-EVEN NUCLEI

THE vibrational-spherical model of Goldhaber and Weneser<sup>1</sup> which had considerable success in correlating the properties of even-even nuclei, such as energy-ratios, etc., does not make any quantitative predictions concerning these properties. The Davydov and Filippov<sup>2</sup> model based on the assumption that the energy levels of even-even nuclei, away from deformed region can be represented as rotational levels of an asymmetric rotor, on the other hand, makes quantitative predictions regarding the specific properties of even-even nuclei. One such parameter is the mixing ratio in  $2' \rightarrow 2$  transition.

Another model which makes quantitative prediction concerning the mixing ratio is the single particle model.

In this note we have carried out a comparison between the predictions of the S-P model and the D-F model regarding the  $M_1-E_2$  mixing ratio.

The mixing ratio of  $2' \rightarrow 2$  transition of  $2' \rightarrow 2 \rightarrow 0$  spin sequence of even nuclei can be defined as

$$\delta^2 = \frac{T(E_2)}{T(M_1)}.$$

The expressions for the mixing ratio in the two models considered are given as :

$$\delta_{DF}^2 = \frac{0.21k^2}{80} \left( \frac{eZR_0^2}{\mu_0 g R} \right)^2 \quad \text{--- D-F Model}^2$$

and

$$\delta_{SP}^2 = 2.642 \times 10^{-8} E_\gamma^2 A^{4/3} \quad \text{--- S-P Model.}^3$$

## LETTERS TO THE EDITOR

## TYPE-N GRAVITATIONAL WAVES IN NON-EMPTY SPACE-TIME

In an earlier paper<sup>1</sup> the author has given three exact solutions of the Einstein-Rosen<sup>2</sup> cylindrically symmetric space-time corresponding to the field equations of Lichnerowicz's<sup>3</sup> total radiation. The solutions were interpreted as representing a fluid distribution of photons with null geodesics as world lines of flow. In a recent survey article on gravitational radiation theory Pirani,<sup>4</sup> while commenting on gravitational radiation in non-empty space-time, wrote '...it is natural to presume, for example, that a space-time with matter and a type N or type III Weyl tensor is pervaded by gravitational radiation'. The object of the present note is to show that in fact one of our total radiation solutions possesses Weyl tensor exactly of type N and therefore can be interpreted as representing gravitational radiation in non-empty space-time.

The Einstein-Rosen metric for cylindrically symmetric space-time can be expressed in polar co-ordinates as

$$ds^2 = e^{2\gamma-2\psi} (dt^2 - dr^2) - r^2 e^{-2\psi} d\phi^2 - e^{2\psi} dz^2 \quad (1)$$

where  $\gamma$  and  $\psi$  are functions of  $r$  and  $t$  only. In the earlier cited reference of the author it has been shown that with

$$\psi = 0, \quad \gamma = \gamma(r-t), \quad (2)$$

(1) represents a universe filled with total radiation. The space-time is not empty because

$$R_1^1 = -R_4^4 = R_1^4 = -R_4^1 = \frac{e^{-2\gamma}\gamma'}{r}. \quad (3)$$

Here and in what follows an over-head dash for  $\gamma$  represents a differentiation with respect to the argument  $(r-t)$ .

The only non-vanishing components of the Weyl curvature tensor for (1) with the values of  $\psi$  and  $\gamma$  given in (2) are

$$\begin{aligned} -\frac{S_{1212}}{r^2} &= -\frac{S_{1224}}{r^2} = -\frac{S_{2424}}{r^2} = S_{3131} = -S_{3134} \\ &= S_{3434} = \frac{\gamma'}{2r}. \end{aligned} \quad (4)$$

Now following Pirani's<sup>5</sup> scheme, the physical components of the Weyl curvature tensor given in (4) with the tetrad

$$\begin{aligned} \lambda_{(1)}^i &= (e^{-\gamma}, 0, 0, 0), \\ \lambda_{(2)}^i &= (0, 1/r, 0, 0), \\ \lambda_{(3)}^i &= (0, 0, 1, 0), \\ \lambda_{(4)}^i &= (0, 0, 0, e^{-\gamma}) \end{aligned}$$

can be written in the form

$$S_{AB} = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -\sigma & 0 & 0 & 0 & \sigma \\ 0 & 0 & \sigma & 0 & \sigma & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & \sigma & 0 & \sigma & 0 \\ 0 & \sigma & 0 & 0 & 0 & -\sigma \end{bmatrix} \quad (A, B = 1, \dots, 6)$$

where  $\sigma = -e^{-2\gamma}\gamma'/2r$ . Therefore the cylindrically symmetric space-time given by (1) and (2) has Weyl tensor of type N and represents gravitational radiation in non-empty space-time.

The author's grateful thanks are due to Prof. P. C. Vaidya for his help in the preparation of this note.

Dept. of Mathematics, J. KRISHNA RAO.  
Gujarat University,  
Ahmedabad-9, June 25, 1963.

1. Krishna Rao, J., To appear in *Proc. Nat. Inst. Sci., India*.
2. Einstein, A. and Rosen, N., *J. Franklin Inst.*, 1937, **223**, 43.
3. Lichnerowicz, A., *Annali di Matematica pura ed applicata* (iv), 1960, **50**, 450.
4. Pirani, F.A.E., *Recent Developments in General Relativity*, Pergamon Press, 1962, p. 103.
5. —, *Phys. Rev.*, 1957, **105**, 1089.

## ON THE GEOMETRY OF LORENZ CURVE OF CONCENTRATION FOR TRUNCATED EXPONENTIAL, PARETO AND LOGNORMAL DISTRIBUTIONS

It is known<sup>1</sup> that the point D where the tangent to the Lorenz Curve of a Lognormal distribution is parallel to the egalitarian line lies on the other diagonal of the unit square. M. P. Sastry<sup>2</sup> has proved that, in the case of an Exponential distribution, D is below the other diagonal; whereas, for a Pareto distribution, D is above the other diagonal. By consideration of limit situations, K. Nagabhushanam and M. P. Sastry<sup>3</sup> conjectured that the position of D will continue to be below or above the other diagonal of the unit square according as the original distribution is Exponential or Pareto even when the distribution is truncated at the right tail end. The object of the present note

is to prove these conjectures, and also to examine the nature of the corresponding geometry of the Lorenz Curve for a Lognormal distribution with its right tail end being truncated.

2. Exponential distribution :

$$dF(x) = c \cdot e^{-cx} dx, \quad c > 0, \quad 0 \leq x \leq \infty.$$

The sum of the co-ordinates of D ( $x_1, y_1$ ) works out to

$$\frac{1 - e^{-k}}{F(a)} + \frac{1}{k \cdot F(a)} [1 - e^{-k} - k e^{-k}]$$

where

$$F(a) = 1 - e^{-ac}, \quad K = 1 - \frac{ac e^{-ac}}{F(a)},$$

and  $a$  is the point of truncation. It is easy to see that there exists an  $a_0 > 0$ , such that, for  $a > a_0$ ,  $x_1 + y_1 < 1$ . How small  $a_0$  can be made depends on how effectively inequalities are used. But the point of interest is that in almost all practical cases of truncation,  $a$  is large enough for easily establishing that  $x_1 + y_1 < 1$ , i.e., D is below the other diagonal of the unit square.

3. Pareto distribution :

$$dF(x) = ax_0^a x^{-a-1} dx, \quad a > 1, \quad x \geq x_0.$$

When a Pareto distribution, truncated at the right tail end, is considered, the sum of the co-ordinates ( $x_1, y_1$ ) of the point D on the Lorenz Curve, where the tangent is parallel to the egalitarian line, is

$$\frac{1}{k} (1 - M^{-a}) + \frac{1 - M^{1-a}}{1 - \left(\frac{a}{x_0}\right)^{1-a}},$$

where  $a$  ( $> x_0$ ) is the point of truncation, and

$$k = 1 - \left(\frac{x_0}{a}\right)^a,$$

and

$$M = \frac{1 - \left(\frac{a}{x_0}\right)^{a-1}}{k \left(1 - \frac{1}{a}\right)}.$$

From this it can be established that  $x_1 + y_1 > 1$  which proves the conjecture that D continues to lie above the other diagonal of the unit square.

4. Lognormal distribution :

$$dF(x) = \frac{1}{2\pi\sigma x} \cdot e^{-(1/2\sigma^2) (\log x - \mu)^2} dx, \\ \mu > 0, \quad \sigma > 0, \quad 0 \leq x \leq \infty.$$

In this case it is not possible to conjecture straight-away by consideration of the limiting

situation how the point D will behave when the right tail of the Lognormal distribution is truncated. The author has carried out numerical work which has led him to the following conjecture :

D will now be situated above the other diagonal but will move to it as the point of truncation moves to infinity.

My thanks are due to Prof. K. Nagabhushanam for the help and guidance in the preparation of this paper.

Andhra University,  
Waltair, June 17, 1963.

P. SAMBAMURTY.

1. Aitchison, J. and Brown, J. A. C., *The Lognormal Distribution*, University of Cambridge.
2. Sastry, M. P., *Unpublished Ph.D. Thesis*, Andhra University, Waltair, 1960.
3. Nagabhushanam, K. and Sastry, M. P., *A Study of Rural Income Distribution*, Second Indian Econometric Conference, Waltair, June 1961.

### ON THE MIXING RATIOS ( $M_1-E_2$ ) IN SOME EVEN-EVEN NUCLEI

THE vibrational-spherical model of Goldhaber and Wenner<sup>1</sup> which had considerable success in correlating the properties of even-even nuclei, such as energy-ratios, etc., does not make any quantitative predictions concerning these properties. The Davydov and Filippov<sup>2</sup> model based on the assumption that the energy levels of even-even nuclei away from deformed region can be represented as rotational levels of an asymmetric rotor, on the other hand, makes quantitative predictions regarding the specific properties of even-even nuclei. One such parameter is the mixing ratio in  $2' \rightarrow 2$  transition.

Another model which makes quantitative prediction concerning the mixing ratio is the single particle model.

In this note we have carried out a comparison between the predictions of the S-P model and the D-F model regarding the  $M_1-E_2$  mixing ratio.

The mixing ratio of  $2' \rightarrow 2$  transition of  $2' \rightarrow 2 \rightarrow 0$  spin sequence of even nuclei can be defined as

$$\delta^2 = \frac{T(E_2)}{T(M_1)}.$$

The expressions for the mixing ratio in the two models considered are given as :

$$\delta_{DF}^2 = \frac{0.21k^2}{80} \left( \frac{eZR_0^2}{\mu_0 g R} \right)^2 \quad \text{--- D-F Model}^2$$

and

$$\delta_{SP}^2 = 2.642 \times 10^{-6} E_\gamma^2 A^{1/3} \quad \text{--- S-P Model}^2$$

In the present analysis the values of the experimentally determined mixing ratio have been collected for the even-even nuclei which are characterised by  $2' \rightarrow 2 \rightarrow 0$  spin sequence. All the data collected from the various publications are presented in Table I. Columns 1 and

2 represent the various even-even nuclei and the energy of  $\gamma$ -transition for the cascade  $2' \rightarrow 2$ . Columns 3, 4 and 5 indicate the mixing ratios obtained from single particle model, Davydov and Filippov model and the experimentally determined value represented by  $\delta^2_{\text{exp}}$ .

TABLE I

1	2	3	4	5	6	7	8
Nucleus	Energy (Kev)	$\delta^2_{\text{sp}}$	$\delta^2_{\text{DF}}$	$\delta^2_{\text{exp}}$	(5) (3)	(5) (4)	Reference
$^{56}_{26}\text{Fe}_{30}^{56}$	1812	0.01858	37.59	0.0225	1.211	0.0005987	a
$^{58}_{26}\text{Fe}_{32}^{58}$	857	0.0004356	8.812	5.383	12360.0	0.6108	a
$^{76}_{34}\text{Se}_{42}^{76}$	659	0.0003693	12.77	13.77	37290.0	1.078	a
$^{90}_{40}\text{Zr}_{50}^{90}$	900	0.000719	43.14	0.000022	0.03091	0.0000005	a
$^{102}_{44}\text{Ru}_{58}^{102}$	693	0.000514	29.79	>225	>437700.0	>7.553	b
$^{114}_{48}\text{Cd}_{66}^{114}$	1.263	0.002323	162.0	0.01124	4.823	0.0000693	d
$^{116}_{50}\text{Sn}_{66}^{116}$	818	0.000999	74.80	12.26	12280.0	0.1639	a
$^{122}_{52}\text{Te}_{70}^{122}$	693	0.0007668	62.05	10.30	13430.0	0.1660	a
$^{134}_{52}\text{Te}_{82}^{134}$	723	0.0008537	69.07	1.0	1171.0	0.01448	a
$^{126}_{52}\text{Te}_{74}^{126}$	750	0.0009164	64.06	77.4	84450.0	1.208	a
$^{126}_{54}\text{Xe}_{72}^{126}$	480	0.000088	33.55	>25	>284100	>0.7452	c
$^{128}_{54}\text{Xe}_{74}^{128}$	540	0.000496	43.17	41.0	82660.0	0.9497	c
$^{132}_{56}\text{Cs}_{76}^{132}$	283.35	0.0002347	42.77	42.25	1800000.0	0.9879	d
$^{194}_{78}\text{Pt}_{116}^{194}$	293	0.0002547	46.36	846.8	3325000.0	18.27	a
$^{196}_{78}\text{Pt}_{118}^{196}$	331.3	0.0003302	60.10	29.48	89280.0	0.4793	d
$^{198}_{80}\text{Hg}_{118}^{198}$	625.7	0.01392	266.7	0.9717	698.1	0.003643	d
$^{200}_{80}\text{Hg}_{120}^{200}$	579.4	0.001037	198.6	0.05	48.22	0.0002518	d

(a) Malik, S. S., Potnis, V. R. and Mandeville, C. E., *Nucl. Phys.*, 1959, **11**, 691.

(b) McGowan, F. K. and Stelson, P. H., *Phys. Rev.*, 1961, **123**, 2131.

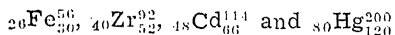
(c) Asplund, I., Strömberg, L. G. and Wiedling, T., *Arkiv för Fysik*, 1960, **18**, 65.

(d) Van Patter, D. M., *Nucl. Phys.*, 1959, **14**, 42.

$\delta_{\text{DF}}^2$  and  $\delta_{\text{exp}}^2$ , respectively. Columns 6 and 7 represent the ratios  $\frac{\delta_{\text{exp}}^2}{\delta_{\text{SP}}^2}$  and  $\frac{\delta_{\text{exp}}^2}{\delta_{\text{DF}}^2}$ , respectively.

The last column gives the reference for the various nuclei.

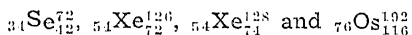
Conclusions.—(1) The cases



agree better with the single particle estimate than the D-F model estimate.

Note the absence of any correlation with shell closure. For instance,  $^{50}\text{Sn}_{66}^{116}$  does not agree with S-P-estimates.

(2) The cases



agree better with the D-F-prediction than the S-P-estimate.

(3) Trends in deviations :

(a) The deviations from S-P- are mostly in one direction, namely  $\delta_{\text{SP}}^2$  is larger than  $\delta_{\text{exp}}^2$ .

(b) The deviations from D-F are both ways but mostly such that  $\delta_{\text{DF}}^2 < \delta_{\text{exp}}^2$ . This would perhaps indicate that a combination of the two models in some way might reproduce the observed  $\delta^2$  values.

(4) From this analysis it appears that there is no strong reason to prefer D-F model, which makes the rather unphysical assumption of nuclei not possessing axial symmetry, over the conventional models.

Department of Physics, S. M. BRAHMAVAR.  
Karnatak University, M. K. RAMASWAMY.  
Dharwar-3, March 23, 1963.

1. Scharff-Goldhaber, G. and Weneser, J., *Phys. Rev.*, 1955, **98**, 212.
2. Davydov, A. S. and Filippov, G. F., *Nucl. Phys.*, 1958, **8**, 237.
3. See for instance: S. A. Moszkowski in *Beta and Gamma-ray Spectroscopy*, Edited by K. Siegbahn, North Holland Publishing Co., 1955.

# IDENTIFICATION OF S-METHYL CYSTEINE SULPHOXIDE BY PAPER CHROMATOGRAPHY. IN PRESENCE OF OTHER S-CONTAINING AMINO-ACIDS

The occurrence of S-methyl cysteine sulphoxide (MCS) in various plant extracts is shown by Synge and Wood<sup>1</sup> and by Morris and Thompson.<sup>2</sup> Their findings are that S-methyl cysteine sulphoxide occurs as a free amino-acid in a number of plants in the crucifera family.

Synge and Wood<sup>1</sup> have used paper chromatographic technique for the identification and dis-

tribution of MCS in various plant extracts. Juice expressed after ether treatment was desalted and the desalted juice was subjected to two-dimensional filter-paper chromatography. To a duplicate, MCS was added as a control. While in every case of negative result inferences can be drawn as to the absence of MCS in the original juice, positive results according to them cannot be taken as a conclusive evidence for the presence of MCS as many other amino-compounds are known to occupy similar positions in the chromatograms.

For two-dimensional paper chromatography of S-methyl cysteine and its sulphoxide, Synge and Wood<sup>1</sup> have used collidine-water and phenol-ammonia as the developing solvents. Although S-methyl cysteine sulphoxide occupies a distinct position, S-methyl cysteine formed by acid hydrolysis of the former by 6N HCl, occupies the position of valine using the same solvent system. Morris *et al.*<sup>2</sup> using the system phenol-water and butanol-acetic acid encountered the same difficulties, as S-methyl cysteine sulphoxide tends to overlap glutamine, while S-methyl cysteine superimposes on  $\gamma$ -amino-butyric acid in these chromatograms.

In this communication, a method for the identification of MCS in presence of other sulphur-containing amino-acids is described. This method is based on selecting a different solvent system elaborated by I. Smith,<sup>3</sup> viz., phenol-ammonia in one direction and butanol-acetic acid-water in the other direction. The method outlined also can ascertain the presence of MCS, by the use of a location reagent for sulphur-containing amino-acids.

As the Rf values for MCS are not worked out, for the solvent system used by Smith (*loc. cit.*) the determination of these is first undertaken. S-methyl cysteine is synthesised by the method outlined by Helmet Zahn *et al.*<sup>4</sup> and converted into its sulphoxide by heating with 30% hydrogen peroxide for 2 hours at 50° C.

S-methyl cysteine sulphoxide is then subjected to a two-way chromatography and its position located. It occupies a position near the basic amino-acids on the solvent systems butanol-acetic A-water and phenol-ammonia as described by Smith [Rf values found are for MCS—0.17 (butanol-acetic A), 0.70 Phenol-ammonia]. S-methyl cysteine and its sulphoxide respond to potassium iodoplatinate test for sulphur-containing amino-acids.<sup>5</sup> Thus the sulphur-containing amino-acids can be located by the iodoplatinate test when white spots will be obtained against a pink background,

Spot of MCS is marked A in Fig. 1.

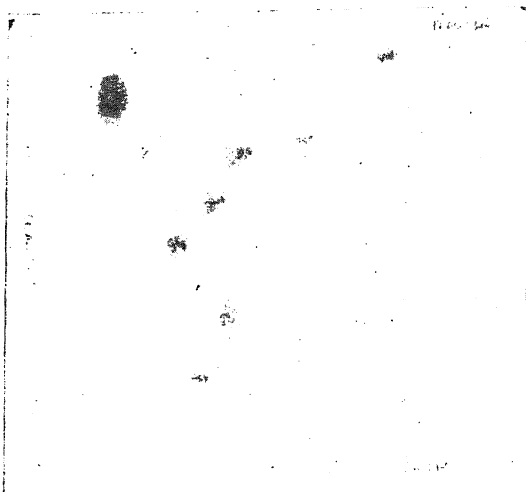


FIG. 1. Two-dimensional paper chromatography of amino-acids using Butanol : Acetic A; Phenol : Ammonia as developing solvents. Circle marked A shows MCS, using potassium iodoplatinate as the location reagent, followed by ninhydrin staining.

When a sample containing S-methyl cysteine sulphoxide is boiled with 6 N HCl, the excess acid removed and the sample chromatographed using the same solvent systems as above, a new spot occupying the position of S-methyl cysteine appears (Rf Bu A—0.33, Ph Am—0.78) which is due to the reduction of MCS to S-methyl cysteine. This conclusively confirms MCS, coupled with the use of the location reagent potassium iodoplatinate.

Experiments carried on in this laboratory could locate MCS in various plant extracts using the technique described.

Department of Chemistry,  
Gauhati University,  
May 31, 1963.

R. K. BARUA.  
K. BHUYAN.

## STRUCTURE OF PIPLARTINE— A NEW ALKALOID FROM PIPER LONGUM

IN a previous communication<sup>1</sup> isolation of triacontane, 22-23-dihydrostigmasterol, an uncharacterised steroid and two alkaloids, piperine and piplartine, were reported from the stems of *Piper longum*, commercially available as 'piplamool'. The present paper deals with the elucidation of the structure of piplartine which has now been identified as piperidine amide of 3, 4, 5-trimethoxycinnamic acid, a hitherto unreported alkaloid.

Piplartine (m.p. 124-125°) was found to be a weakly basic alkaloid which failed to form any salts with mineral acids. Its insolubility in dilute acids and alkalis in the cold but ready solubility on refluxing indicated that the nitrogen might be present in the form of amide linkage. This was also to be expected on biogenetic consideration of the family *Piperaceae*. Piplartine gave positive tests for unsaturation and alkoxy group.<sup>2</sup> A positive König's colour reaction<sup>3</sup> indicated that piplartine was a piperidine derivative. Reaction for the detection of methylene dioxy group,<sup>4</sup> which is present in piperine, was negative in case of piplartine.

The IR spectrum of piplartine shows a definite carbonyl group at 5.94 microns and CH stretching at 3.52 microns due to piperidine ring. A comparison of IR spectra of piplartine and piperine suggested a number of points of resemblance but some differences such as a shift in the carbonyl and dioxalane ring absorbance. This indicated that dioxalane ring present in piperine was in some way altered in piplartine.

Piplartine was hydrolysed by refluxing with 10% alcoholic potassium hydroxide. The hydrolysate on fractional distillation gave a base giving test for secondary amine<sup>5</sup> and presence of piperidine could be confirmed by paper chromatography using authentic piperidine as a reference and solvent system *n*-butanol : acetic acid : water (4 : 1 : 5). The base could also be isolated as its picrate but the amount of crystalline picrate obtained was too small for further investigation.

The hydrolysate, after removal of the base, was acidified with dilute hydrochloric acid and extracted with benzene. The residue from benzene extracts, after several crystallisations from water, gave colourless glistening crystals, m.p. 126-127°. The compound was acidic and

1. Synge, R. L. M. and Wood, J. C., *Biochem. J.*, 1956, **64**, 252.
2. Morris, C. J. and Thompson, J. F., *J. Am. Chem. Soc.*, 1956, **78**, 1605.
3. Smith, I., *Chromatographic Techniques*, William Heinemann Medical Books Ltd., London, 1958.
4. Zahn, H. and Traumann, K., *Ann.*, 1953, **581**, 168; cited from *C.A.*, 1955, **49**, 6834 *e*.
5. Toennies, G. and Kolb, J. J., *Anal. Chem.*, 1951, **23**, 825.



showed the presence of unsaturation and methoxy grouping. Its elemental analysis (C, 60.44; H, 5.82;  $-\text{OCH}_3$ , 39.28%) corresponds to the empirical formula  $\text{C}_{12}\text{H}_{14}\text{O}_5$  and indicates the presence of three methoxy groups. A mixed m.p. of the isolated acid with pure 3, 4, 5-trimethoxycinnamic acid was undepressed. Methyl ester of the isolated acid gave m.p. 90-91° (reported<sup>6</sup> for methyl ester of trimethoxycinnamic acid, m.p. 91-91.5°). The identity was finally confirmed by comparing the IR spectrum of the isolated acid with that of 3, 4, 5-trimethoxycinnamic acid reported by Sadtler.<sup>7</sup>

Pipltartine could also be reconstituted by converting 3, 4, 5-trimethoxycinnamic acid to its chloride using thionyl chloride method<sup>8</sup> and reacting it with piperidine. The reaction mixture failed to give a crystalline product but its R<sub>f</sub> value (0.85) on paper chromatograms (butanol: acetic acid: water: 4:1:5) was identical with that of naturally isolated pipltartine (R<sub>f</sub> 0.83).

The evidence presented in the foregoing establishes the identity of pipltartine as piperidine amide of 3, 4, 5-trimethoxycinnamic acid.

We are grateful to Dr. A. E. Schwarting of the University of Connecticut, U.S.A., and Dr. A. R. Gennaro of Philadelphia College of Pharmacy for the IR data, to Dr. M. L. Dhar and Dr. M. W. Klohs of C. D. R. Laboratory, Lucknow, and Riker Laboratory, California, respectively, for the microanalysis and to Dr. K. N. Gaiind for encouragement during the course of this investigation.

Department of Pharmacy, C. K. ATAL.  
Panjab University, S. S. BANGA.  
Chandigarh, February 18, 1963.

1. Atal, C. K. and Banga, S. S., *Indian J. Pharm.*, 1962, 24, 105.
2. Shriner, R. L., Fusen, R. C. and Curtin, D. Y., *The Systematic Identification of Organic Compounds*, John Wiley & Sons, Inc., London, 1956, p. 116.
3. Macek, K., Iláčapekova, J. and Kakac, B., *Pharmazie*, 1956, 11, 16.
4. Gabel, *Arch. Pharm.*, 248, 225, through Atal, C. K., *A Pharmacogenetic Study of Withania somnifera Dunnal*, Doctoral Thesis, Univ. of Connecticut, Storrs, 1957, p. 52.
5. Feigl, F., *Spot Test in Organic Analysis*, Elsevier Publishing Co., London, 1956, p. 262.
6. Heilbron, I. and Bunbury, H., *A Dictionary of Organic Compounds*, Eyer and Spottiswood, London, 1953, p. 360.
7. *Sadtler Standard Spectra*, J. Sadtler & Co., Philadelphia.
8. Klohs, M. W., Draper, M. D. and Keller, F., *J. Am. Chem. Soc.*, 1955, 77, 2243.

## SITE OF SYNTHESIS OF ALKALOIDS IN SOME PLANTS

JAMES (1946) invited attention towards the root as locus of synthesis of alkaloids. He demonstrated that *A. belladonna* seedlings when treated with Bouchardat's reagent diffused a red cloud out of the tissue for a short distance into the surrounding fluid. He assumed the presence of the tropane alkaloids in the germinating radicle but R. van Haga (1954) opined that the alkaloid was probably bellaradine.

A few important plants of Solanaceae like *Datura stramonium* and *Nicotiana* sp. have been similarly investigated by other workers (James, 1953). The following plants were treated for the same purpose in view and the observations are recorded hereunder.

*Physochlaina preleata* (D) Miers. is an important Solanaceous plant which yields hyoscyamine alkaloids up to 1.05%. The alkaloids are reported in leaf and root but not in seeds. When the seeds are germinated in sand culture and the radicle is treated with Wegnin solution the alkaloidal precipitate is formed. James' technique with some modification was employed to detect the presence of alkaloids.

The radicle as it came out was severed and kept under the microscope after its measurement had been taken. A drop of ether was placed over it. A drop of Wegnin solution was put on the radicle when the ether had just evaporated. The radicle was kept under observation with an 1.25 cm. objective microscope. The red colour was diffused in the zone between the root-cap and root-hairs. A radicle measuring 6 mm. behind the root-cap gave a strong positive reaction for the alkaloids. No reaction was, however, observed in the region where the root-hairs arise.

*Datura innoxia*.—This is another important plant containing alkaloids of hyoscyamine and scopolamine in all parts of plant, viz., leaf, root and seed. The radicles of germinating seeds showed no reaction of alkaloids with Wegnins reagent in the root-cap but strong positive reaction for alkaloids was observed in the segment behind the root-cap, but again not in the place where root-hairs arise.

*Papaver somniferum* L. (Opium Poppy) which yields the opium alkaloids belongs to Papaveraceae of which all plants contain alkaloids (Hocking). Opium alkaloids are found in all parts of Poppy, viz., root, leaf and stem but the capsule is the main repository of the alkaloids. These alkaloids are, however, notably absent from seeds.

Fairbairn and Kapoor (1959) observed that the germinating seedlings do not show presence of any alkaloids in the radicle. By detailed anatomical studies they observed that the laticiferous vessels in which the alkaloids reside appear in the seedlings only when the cotyledons open but the alkaloids are detected after the first two leaves have come out. They concluded that the leaf, and not the roots, is the site of synthesis of alkaloids in *P. somniferum*. These findings were confirmed by ascending paper chromatographic technique they employed in the detection of alkaloids.

These observations confirm the general conclusion for Solanaceous plants that the site of synthesis of alkaloids in the case of *Physochlaina preleata* and *Datura innoxia* is the root. But in the case of *Papaver somniferum* it is the leaf and not the root where the alkaloids are synthesised.

Regional Research Laboratory, L. D. KAPOOR.  
Jammu, February 15, 1963.

1. James, W. O., *Nature*, 1946, 158, 377.
2. —, *Jour. Pharm. Pharmacol.*, 1953, 5, 809.
3. Fairbairn, J. W. and Kapoor, L. D., *Planta Medica*, 1960, 8, 49.
4. Reinoutz van Haga, P., *Nature*, 1954, 173, 692.
5. Hocking, G. M., *A Dictionary of Terms in Pharmacognosy*, C. C. Thomas, Publisher, Springfield, Illinois, U.S.A., 1955.

### DIPOLE MOMENT OF DYES

THE dipole moments of two dyes have been determined in three different solvents, benzene, toluene, and xylene. The dyes used are, (i) waxoline yellow ADS which consists of two substituents of aniline and dimethylaniline connected by N—N linkage and (ii) a complex dye waxoline rhodamine B.S. The dielectric constant was determined by the beat frequency oscillator. The crystal oscillator had a frequency 3202.5 k.c./sec.

The molar polarization of the solute for infinite dilution was determined by graphical extrapolation and the electronic polarization was calculated by the method of least squares. All the observations were taken at 30° C.

The dipole moments of the dyes are given in Table I.

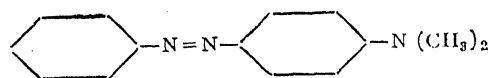
The dipole moments are observed to be in decreasing order from benzene to toluene and xylene.

The authors wish to thank the Imperial Chemical Industries, India, Ltd., for supplying the dyes used in this work.

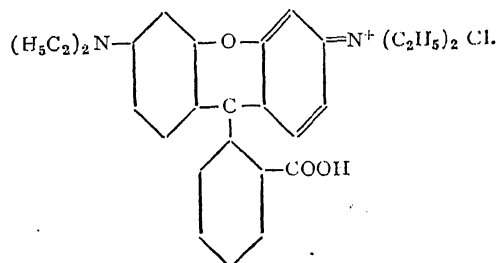
TABLE I  
Dipole moments of Waxoline Yellow ADS and  
Waxoline Rhodamine B.S. in three different  
solvents

Solute	Dipole Moment (Debye units) in		
	Benzene	Toluene	Xylene
Waxoline Yellow ADS ..	2.82	2.72	2.62
Waxoline Rhodamine B.S. ..	5.68	5.47	5.37

Formulae of two dyes :



Waxoline Yellow ADS



Waxoline Rhodamine B.S.

Purity of two dyes is 99.99% as the commercial samples were purified by dissolving them in benzene and using the filtrate for repurification. The residue from the samples was found to be about 10%.

K. J. Somaiya College, D. D. DESAI.  
Bombay-77.

Khalsa College, N. H. PANDHARE.  
Bombay-19, February 22, 1963.

### ARGILLISATION AND WALLROCK ALTERATION AT MOSABHONI COPPER MINES, SINGBHUM DISTRICT, BIHAR

VARIOUS studies of hydrothermally altered rocks from mineralised horizons have been made to establish criteria to guide exploration and location of new ore-bodies. Considerable attention has been bestowed to such studies elsewhere. The purpose of this study in the Mosabhoni Copper Mines is to investigate if any such criteria exist here. Several specimens were collected from various levels for this study.

The general approach made during this study is similar to the one given by Creasey,<sup>1</sup> who

envisaged a threefold facies of hydrothermal alteration, which are (i) prophyllitic facies consisting predominantly of montmorillonite, epidote, clinozoisite, chlorite and kaolinite, (ii) argillic facies represented by such minerals as chlorite, kaolinite and illite and (iii) potassium silicate facies consisting of muscovite, hydromica, sericite, recrystallized biotite and tourmaline. The threefold division was revised into a two-fold one by Burnham<sup>2</sup> which consists of argillic and phyllic facies.

The following three zones could be delineated in the Mosabehoni Mines: (i) a foot wall zone consisting predominantly of montmorillonite, epidote, clinozoisite, chlorite and kaolinite characteristic of the prophyllitic type; (ii) a central zone with chlorite, kaolinite and illite and (iii) followed on the hanging wall side by a zone of muscovite, hydromica, sericite, recrystallized biotite and pinkish and bluish-green tourmaline.

X-ray studies have revealed the presence of montmorillonite, chlorite (pinninite variety with unit cell dimensions C-axis 14.15 Å, B = 97°, a = 5.3, b = 9.20), kaolinite (7.10 Å to 7.15 Å), illite (10.00 Å) and biotite (phlogopitic). Montmorillonite is predominant in the foot wall side and kaolinite attains maximum development in the central zone of the comparatively more intensely sheared and altered sodagranite. Illite is predominant in the mineralised horizons, and also in areas of intense alteration.

The derivation of a variety of alteration products was indicated when the complex mineral biotite is subjected to hydrothermal agencies at moderate temperatures and pressures. The different stages of biotite alteration were studied. The normal brown biotite frequently alters to a feebly brown or green variety, then to green chlorite and finally to illite. This is borne by optical, chemical and X-ray studies. The results are given in Table I.

TABLE I

	C-axis	Ref. index	Total Iron %
1. Primary brown biotite	.. 10.40	1.690	12.30
2. Faded brown biotite	.. 10.16	1.550	6.85
3. Green chlorite	.. 10.10	1.520	4.45
4. Illite	.. 10.00	..	Traces

Two varieties of secondary muscovite after biotite were noticed, which are (i) perfect or nearly perfect pseudomorphs of colourless mica after biotite and (ii) flaky or fibrous pseudo-

morphs. Besides this, unusual occurrence of biotite being partly replaced by tourmaline was also noticed. Development of epidote and zoisite in biotite is characteristic of the prophyllitic facies of the first zone. Elimination of titanium and iron from biotite takes place during its alteration with the development of pyrite and chalcopyrite. The combination of sulphur with the released iron from the biotite alteration seems to favour the formation of pyrite and chalcopyrite.

Hypogene nature of the clay minerals is suggested by the following observations: (i) Supergene oxidation of sulphides is slight even at the surface samples. Abundant primary sulphide minerals including pyrite, arsenopyrite, pyrrhotite and chalcopyrite are found at the surface without any alteration; (ii) the argillised zones (900 to 2,600 feet below the surface) that are now being investigated lie beneath the water-table; (iii) the amount of argillisation increases with the mineralisation; and (iv) spectrochemical analyses<sup>3</sup> show similarities in the trace element content of the altered minerals and clay minerals in all respects, but there is a marked difference between the trace elements of the unaltered minerals and the altered minerals (including clay minerals).

From the above, the temperature range of ore solution during mineralization and argillization seems to be 400° to 450° C., with a change from acidic to alkaline medium as evidenced by the development of montmorillonite and zeolites. It may be concluded that reliable guides to the occurrence of the ore bodies are, (i) highly sericitised zone in association with maximum fracturing and tensional dilation, (ii) the prevalence of copper content<sup>4</sup> above 300 p.p.m. with nickel and cobalt contents of 50 p.p.m. and 20 p.p.m. respectively and lastly (iii) the presence of traces of molybdenum.

The authors desire to express their grateful thanks to late Prof. C. Mahadevan and to Dr. A. Narasinga Rao for his help in spectral analyses. The help and guidance of Dr. C. D. Murthy, Head of the Division of Soil Physics and Dr. B. P. Pal, Director of I.A.R.I., New Delhi, is gratefully acknowledged. The suggestions given by Mr. G. Prabhakara Rao of the Department of Atomic Energy in the preparation of this paper and the facilities afforded by M/s. Indian Copper Corporation, Ghatsila, are thankfully acknowledged.

Geology Department, K. KAMESWARA RAO.  
Andhra University, G. S. R. KRISHNAMURTY.\*  
Waltair, February 5, 1963.

\* Indian Agricultural Research Institute, Pusa, New Delhi.

1. Creasey, S. C., *Eco. Geol.*, 1959, **54**, 351.
2. Burnham, C. W., *Ibid.*, 1962, **57**, 768.
3. Rao, K. K., *Curr. Sci.*, 1962, **34**, 192.
4. —, *D. Sc. Thesis* (in preparation).

### OCCURRENCE OF KHONDALITE FROM THE EXTRA-PENINSULAR REGION CHOR AREA, HIMACHAL PRADESH

PILGRIM AND WEST<sup>1</sup> after a detailed mapping of the rocks of the Simla hills arrived at the conclusion that the Chor granite mass is an intrusive in the Jutogh rocks and that these granites are all of Archæan age. The granites came into existence before the deposition of the Chail series. According to these authors, the granite intrusion was contemporaneous with the recumbent folding and metamorphism and that the Jutogh rocks are the oldest rocks of the area. The sequence of events as established by them is as follows:

11. Cross-faulting and warping of the overthrust planes;
10. Main overthrusting with low grade metamorphism;
9. Folding in of the Subathu with Jaunsar, Simla and Blaini series;
8. Deposition of the Subathu series;
7. Deposition of the Simla to Krol series;
6. Deposition of Chail and Jaunsar series;
5. Intrusion of olivine dolerites soon after the intrusion of Chor granites;
4. Intrusion of Chor granites towards the end of recumbent folding and regional metamorphism;
3. Recumbent folding and regional metamorphism;
2. Intrusion of basic sills and dykes (now hornblende schists);
1. Deposition of Jutogh series.

The rock types so far reported from the Jutogh series of the Chor area are: quartz schists, quartz-mica schist, biotite-muscovite schist, garnetiferous-mica schists, staurolite schists, chlorite and chloritoid schists, slaggy and pitted carbonaceous slates and schists, quartzites, crushed and banded dolomitic marbles generally carbonaceous and often containing actinolite, carbonaceous phyllites often garnetiferous, hornblende schists, amphibolites, Chor gneissose granite and olivine dolerites and a few pegmatites.

It may be interesting to record that neither kyanite nor sillimanite have ever been reported

from the area<sup>1</sup> (p. 68). However, we have found besides the rocks enumerated above, the rocks of the granulite facies, viz., graphite-sillimanite schist, graphite sillimanite gneiss and corundum-bearing schist from the area around the town of Rajgarh (30° 51' 77" 18'), about 3 miles towards the east. The graphite-sillimanite schists and gneisses have been identified with the Khondalites of the Peninsular India. The rocks are highly crushed at places. It is interesting to mention that at certain places the carbonaceous graphite-sillimanite schists are outcropping in immediate contact with the chlorite schists which belong to the green schist facies. In view of this abnormal association, it would not be wrong to infer that the contact between the two might be a tectonic contact and the graphite-sillimanite rock has been thrust over the chloritic schist. The carbonaceous series with the khondalitic rock might be a separate series by itself, and different from the other carbonaceous rocks occurring interbedded with Jutogh schists, quartzites and marbles, etc.

Besides the above, we have found evidences of migmatization on a regional scale.

The authors are grateful to Prof. P. R. J. Naidu, for his valuable help and comments.

Department of Geology, M. N. SAXENA.  
Panjab University, R. C. KANWAR.  
Chandigarh, February 22, 1963.

1. Pilgrim, G. E. and West, W. D., *Mem. Geol. Surv. Ind.*, 1928, **53**, 68, 131.

### THERMAL ANALYSIS OF ALTERED ROCKS FROM VEMPALLE LIMESTONE BELT, CUDDAPAH SYSTEM

VEMPALLE limestone belt is hydrothermally altered in the vicinity of basic intrusions. Asbestos and steatite are the two end-products of such alteration. These two minerals occur in different zones of alteration, but not together, though they are similar in chemical composition. In order to identify the intermediate products of alteration leading to the final formation of asbestos in one case and steatite in another, differential thermal analysis of these altered rocks was carried out.

Samples were collected from three places, showing hydrothermal alteration, in the neighbourhood of Mutchukota (77° 52' 38"; 14° 51'), Anantapur District, Andhra Pradesh. Steatite is the end-product at two places, one near Singanaguttapalle (77° 48' 39"; 14° 53' 40") on the western flank of a small hillock and the

other, approximately two and a half miles west of Mutchukota. Asbestos is the end-product at the third place, about half-a-mile south-east of Singanaguttapalle. The differential thermal analysis of the samples was carried out on a portable unit.<sup>1</sup>

The samples analysed fall into three groups on the basis of their thermal behaviour. They are: (i) samples with high-temperature endothermic and exothermic reactions with peaks at about 660° C. and 760° C. respectively, characteristic of serpentine<sup>2</sup>; (ii) those with the above reactions and also some additional reactions due to presence of impurities and (iii) those showing successive high-temperature endothermic reactions with peaks at 600° C., 780° C. and 850° C. characteristic of chlorite.<sup>3</sup> Samples from each of the three places show thermal behaviour distinctly different from the other two. Samples from Singanaguttapalle, where asbestos is the final product, show thermal reactions characteristic of serpentine. In general, the curves of all these samples are closer to the chrysotile curves than to antigorite from the type locality, Val Antigorio, Italy.<sup>4</sup> DTA curves of samples from Singanaguttapalle hillock, where steatite is the end-product, also show the characteristic reactions of serpentine, and in addition those of dolomite and calcite. DTA curves of samples from Mutchukota, where end-product is steatite, show thermal reactions characteristic of chlorite.

It is thus clear from the above results that in asbestos mineralisation the intermediate alteration products are serpentines and in the steatite mineralisation, they may be serpentines or chlorites. It is supposed that the initial composition and the nature of structural disturbance determine the nature of intermediate alteration products in the case of steatite.

I gratefully thank late Prof. C. Mahadevan for his guidance.

Geology Department, C. BORRESWARA RAO.  
Andhra University,  
Waltair, February 25, 1963.

# NATURE OF CONTACT BETWEEN THE LOWER AND THE UPPER MURREES IN JAMMU PROVINCE, J. AND K. STATE\*

REFERENCE is invited to the letter by Dr. G. G. K. Sastri, Director of Geology and Mining, Gujarat State, published in *Curr. Sci.*, Vol. 31, No. 9, p. 377, regarding an unconformity between Lower and Upper Murree sediments in Jammu Province, J. & K. State. This area has been mapped on 1 : 25,000 scale by the undersigned together with Messrs. K. Varadarajan and J. L. Ganju in connection with oil exploration in that region.

The ridge immediately to the north of Sunderbain (33° 03' : 74° 30')-Naoshera (33° 09' 30" : 74° 14' 30") road consists of Lower Siwalik sediments which conformably overlie the Upper Murree sediments exposed on the northern slopes of this ridge. These are the outcrops of the northern limb of the Dandesar Syncline (Dandesar : 33° 07' 42" : 74° 19' 25") which is in faulted contact with the Kalakot Anticlinorium (Kalakot : 33° 13' 37" : 74° 25' 27"). Nearer to Naoshera, however, this ridge swings in towards north, cutting across the general structural trend, and on the Naoshera-Rajaori (33° 22' 30" : 76° 19') road basal Upper Murree sediments of the next structural unit are exposed. These have a faulted contact with the Lower Siwalik sediments to the south.

The Kalakot Anticlinorium exposes Pre-Tertiary limestone in unconformable contact with the near-shore and estuarine sediments of Eocene age, which in turn are conformably overlain by a full sequence of Murree sediments. While the Upper/Lower Murree contact in the southern limb of the Kalakot Anticlinorium is a faulted one, in the northern limb the contact is normal, gradational and undoubtedly conformable. In general, the Lower Murree rocks are more argillaceous than the Upper Murree rocks. The Dandesar Syncline exposes Middle Siwalik rocks in the centre.

The local conglomerate mentioned by Dr. Sastri, south-west of Pathradi (33° 10' : 74° 18' 30") is purely of intra-formational nature, which is of common occurrence in Murree and Lower Siwalik sequences.

No unconformity between Lower and Upper Murree sediments has been noticed in the mapping of the northern ridges of the Himalayan foothills from Sirmur to Rajaori.

The writer is grateful to the Director of Geology, Oil and Natural Gas Commission, for releasing this note for publication.

1. Sarma, B. B. G., *Proc. Ind. Acad. Sci.*, 1960, **51 A**, 280.
2. Hess, H. H., Smith, R. J. and Dengo, G., *Am. Min.*, 1952, **37**, 68.
3. Bradley, W. F. and Grim, K. E., *Ibid.*, 1951, **36**, 182.
4. Nagy, B. and Faust, G. T., *Ibid.*, 1956, **41**, 817.

Directorate of Geology, L. L. BHANDARI.  
Oil and Natural Gas Commission,  
16-A, Lytton Road,  
Dehra Dun, June 4, 1963.

\* The views expressed in the note are those of the author only and not necessarily of the Organisation for which he is working.

### ON THE OCCURRENCE OF RADIOACTIVE CHLORITE IN THE BUNDLEKHAND GRANITES

IN the course of a reconnaissance radiometric survey in parts of the Gwalior and Shivpuri Districts of Madhya Pradesh (Survey of India topo-sheet No. 54 G/NE), the author found radioactivity of the order of 6 to 8 times the background radiation over some outcrops of the Bundlekhand Granites occurring around the villages of Chitoli (25° 47' 16": 77° 58' 20"), Harsi (25° 46' 13": 77° 56' 00"), Narwar (25° 38' 37": 77° 54' 45") and Dhamkan (25° 33' 55": 77° 50' 53"). Studies have shown chlorite to be responsible for this radioactivity. The importance of this find lies in the fact that, as far as it is known to the author, it is the first record of radioactivity in chlorite in the Bundlekhand Granites.

A brief account of some of the characters and probable origin of the mineral is presented here.

*Equivalent uranium content.*—Fractions of the chlorite separated from samples from the different radioactive outcrops radiometrically assayed 0.31% to 0.45% equivalent  $U_3O_8$ .

*Optical properties.*—The mineral shows shades of greens, yellows and browns, the majority of the flakes being non-pleochroic due to radioactive damage and showing distinct metamictization. "Blood red clouds" are found to be developed around certain inclusions (Fig. 1). The refractive index of the mineral as determined by the single variation method using a Leitz U-Stage Refractometer is 1.624.

*Radioactivity.*—Autoradiographs show that most of the radioactivity of the mineral is confined to the "blood red clouds", which resemble the well-known "iron stain" halos surrounding such radioactive minerals as monazite, xenotime, uraninite, thorite, allanite and fergusonite.

*Origin.*—From the manner of occurrence of the radioactive "blood red clouds", the author is led to the inference that they were possibly formed by alteration of small radioactive inclusions in the biotites of the host rock during metasomatism of the latter with concomitant

chloritization of the biotites. This view finds support in the fact that these radioactive granites display marked metasomatic effects such as albitization and carbonatisation, whereas the non-radioactive types of the area do not, and show an absence of radioactive chlorites.

The inclusions around which the "blood red clouds" occur are under study and more data, when available, are likely to throw light on their nature and origin.



FIG. 1

I am grateful to Dr. D. N. Wadia for kindly permitting publication of this paper and to Mr. K. K. Dar and Mr. A. V. Phadke for their guidance and helpful suggestions.

Atomic Minerals Division, S. VISWANATHAN.  
Dept. of Atomic Energy,  
Govt. of India, New Delhi, April 6, 1963.

### MELOIDOGYNE SPP. INFECTING CERTAIN PLANTS IN KERALA

Root-knot nematodes are known to cause considerable damage to plants of economic importance all over the world. These nematodes, known previously under the name *Heterodera radiculicola* (Greef, 1872) Müller, 1884 and *H. marioni* (Cornu, 1879) Goodey, 1932, have been transferred to the genus *Meloidogyne* Goeldi, 1887, by Chitwood.<sup>1</sup> Although several species of *Meloidogyne* infecting a variety of plants have since been reported from different countries, the data concerning their occurrence

in India appear to be very limited. *M. javanica* has been recorded from sugarcane by Rangaswami *et al.*<sup>2,3</sup> and *M. incognita* from jute plants by Chattopadhyay and Sengupta,<sup>4</sup> and from beans by Kannan.<sup>5</sup> The host range of different species of *Meloidogyne*, and the extent to which they cause damage to plants in India, remain to be studied.

In the present study, *Meloidogyne* infection has been detected in the plants, *Zingiber officinalis* Rosc., *Cucurbita maxima* Duchesne, *Hibiscus esculentus* Linn., *Xanthosoma alba*, *Phaseolous multiflorus* Willd., and *Solanum melongena* Linn., collected in the vicinity of Mar Ivanios College, Trivandrum. Examination of the perineal patterns of the adult females recovered from each plant revealed that two species are involved in the infection; one of them has been identified as *M. incognita* and the other tentatively as *M. javanica*. The latter species is associated with *Hibiscus* and the former with the rest of the plants. However, *Hibiscus* plants, collected from a different locality away from the college campus, also showed infection with *M. incognita* suggesting that this plant can act as a host for both of these species.

Infection has been found restricted to the root system of various plants examined. In a few instances, however, it has also been noticed at the base of the stem of *Hibiscus* below soil level. The affected roots showed galling except the main roots of *Zingiber*. The rootlets of this plant exhibited small nodules containing one or two adult females with egg-masses. A comparative study carried out at inter-hostal and inter-species levels as regards intensity of infection, egg-output, nature of gelatinous egg-sacs, and symptoms indicated that the plant *Hibiscus esculentus* is the most susceptible to the attack of root-knot nematodes. The gelatinous matrix of egg-masses of worms recovered from *Hibiscus* is coloured yellow or dark brown, unlike that of the egg-masses from other plants. Galling on the roots of *Solanum melongena* was

not very conspicuous and the adult females remained in the galls with their posterior end protruding into the soil. Males were seldom encountered in the galls except in the main roots of *Zingiber*. The infected plants were characterized by stunted growth, mottled and chlorotic leaves, and poor or no yield.

My thanks are due to the Council of Scientific and Industrial Research, New Delhi, for the financial help, to the authorities of Mar Ivanios College for providing space and facilities, and to Prof. A. P. Mathew for the interest and encouragement.

Department of Zoology, A. M. NADAKAL.  
Mar Ivanios College,  
Trivandrum, February 22, 1963.

- [1. Chitwood, B. G., *Proc. Helm. Soc. Wash.*, 1949, 16, 90.
- [2. Rangaswami, G., Vasantharajan, V. N. and Venkatesan, R., *Curr. Sci.*, 1960, 29, 236.
3. —, Balasubramanian, M. and Vasantharajan, V. N., *Ibid.*, 1961, 30, 149.
4. Chattopadhyay, S. B. and Sengupta, S. K., *Ibid.*, 1955, 24, 276.
5. Kannan, S., *The Presidency College Magazine*, 1961, 8, 82; also Kishen Singh, *Ind. Phytop.*, 1960, 12, 181.

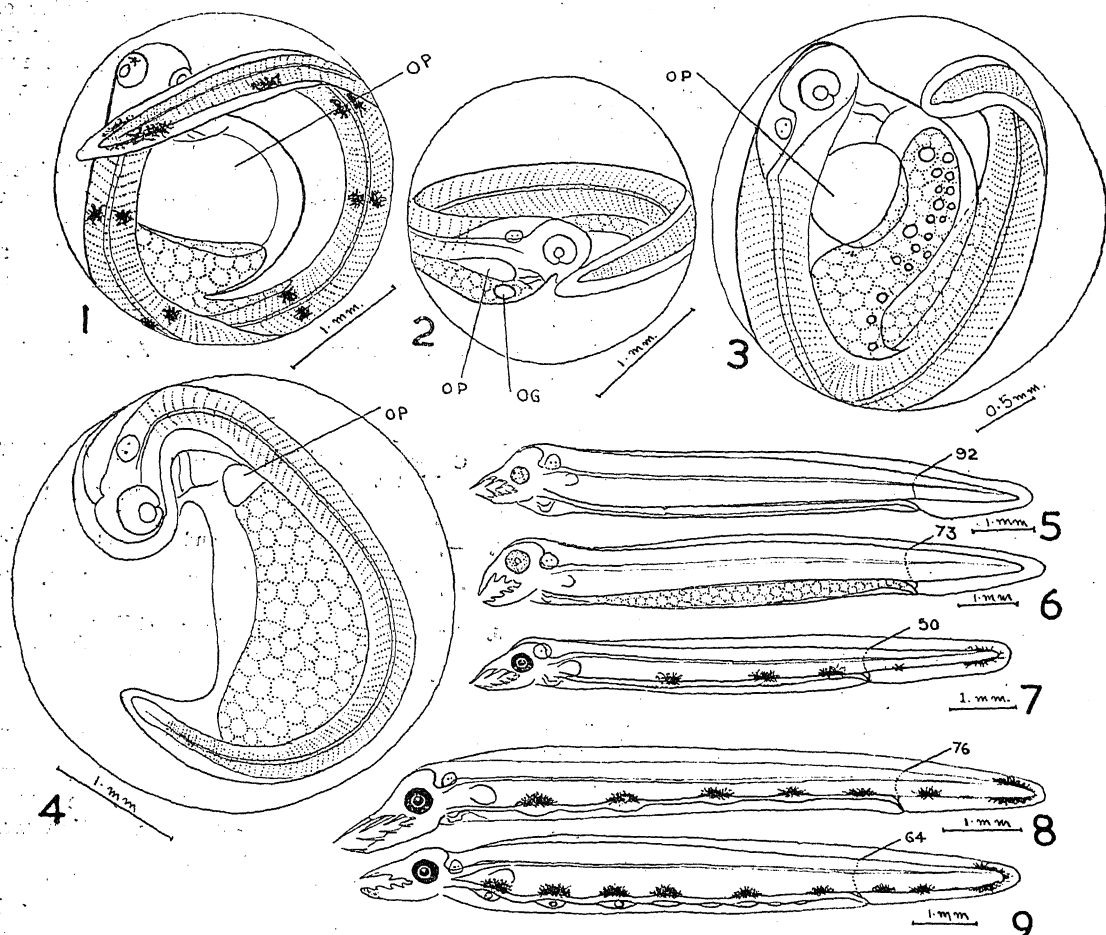
### FISH EGGS OFF WALTAIR COAST

In an earlier paper the present authors<sup>4</sup> gave a review of the literature relating to the eggs and early development of eels from Indian waters and described the egg and early development of an *Ophichthyid* and a *Muraenid* collected from the local plankton. Subsequently Nair and Dharmamba (1960)<sup>6</sup> described the early development of an *Ophichthyid* egg from Lawson's Bay, the hatchling of which had 115 preanal myotomes.

We have so far come across 9 kinds of eggs of eels, 6 belonging to the *Ophichthyidae*, 3 to *Muraenidae*. The distinguishing characters of five types of eggs and larvae of *Ophichthyidae* and two of *Muraenidae* are given in Table I.

TABLE I

Sl. No.	Kind of eggs	Diameter of egg in mm.	Oil globules	Diameter of oil globule in mm.	Hatchling in mm.	Preanal myotomes	Preanal chromatophores	Postanal chromatophores	Total number of chromatophores	
1	<i>Ophichthys</i>	A	2.7-2.8	Absent	..	8	76	5	2	7
2	"	B	2.7-2.3	Present	0.4	7	49	3	2	5
3	"	C	2.3-2.5	"	0.4	7	80	8	4	12
4	"	D	2.3-2.5	"	0.4	9	63	7	3	10
5	"	E	2.75	Many Oil globules	0.05	10	64	6	3	9
6	<i>Muraena</i>	A	3.50	Absent	..	9.5	92	..	..	..
7	"	B	3.25	"	..	10	73	..	..	..



FIGS. 1-9. Fig. 1. 60 hours' old egg of *Ophichthys* A. Fig. 2. 42 hours' old egg of *Ophichthys* B. Fig. 3. 48 hours' old egg of *Ophichthys* E. Fig. 4. 45 hours' old egg of *Muræna* A. Fig. 5. Three days' old larva of *Muræna* A. Fig. 6. Hatchling of *Muræna* B. Fig. 7. Three days' old larva of *Ophichthys* B. Fig. 8. Three days' old larva of *Ophichthys* A. Fig. 9. Two days' old larva of *Ophichthys* E.

OG: oil globule. OP: oesophageal pouch.

The eggs of the *Ophichthyidae* are characterised by the presence of a single or many oil globules and serial arrangement of chromatophores on the alimentary canal and the *Murænid* eggs by the absence of chromatophores (Figs. 1-9). A detailed account of the early development of these different types will be published elsewhere.

Department of Zoology,  
Andhra University,  
Waltair, April 24, 1963.

P. N. GANAPATI.  
N. SOLOMON RAJU.

1. Bapat, S. V., *Indian J. Fisheries*, 1955, 2(1), 231.
2. Delsman, H. C., *Treubia*, 1933, 14, 237.
3. Ehrenbaum, E., *Eier. Und. Larven. Von Fischen Nordisches plankton*, 2, 1-388.
4. Ganapati, P. N. and Solomon Raju, N., *J. Zool. Soc. India*, 1960, 12(2), 229.
5. Nair, R. V. and Bhimachar, B. S., *Proc. Ind. Acad. Sci.*, 1950, 31B(6).
6. — and Dharmamba, M., *Ibid.*, 1960, 52 B, 220.
7. Satoshi Mito, *Science Bulletin of the Faculty of Agriculture*, Kyushu University, 1961, 18(3), 285.



# TOXICITY OF ZINC TO FISH

ZINC SULPHATE is an important constituent in the manufacture of viscose rayon. In view of the possibility of discharge of effluents containing zinc sulphate into natural waters containing fish fauna, the effect of zinc salts on fish is under study. The experimental procedure was based on that of Doudoroff *et al.*<sup>1</sup> Bangkok strain of *Cyprinus carpio* of sizes 2.5-3.0 cm. were used 20 numbers for 10.0 l. water in aquaria jars, the average weight of each fish being 0.21 g. *Tilapia mossambica*, *Danio* sp. and Ooty strain of *Cyprinus carpio* were of sizes 5.0-6.0 cm. and 10 fish were used per 10 l. of water.

The 48 hr. lethal concentration (LC<sub>100</sub>) for Bangkok strain of *Cyprinus carpio* was 12-15 ppm of zinc sulphate, at a pH of 7.0-7.2, methyl orange alkalinity of 46.0 ppm (as HCO<sub>3</sub>) a temperature of 28.0-30.0° C. and dissolved oxygen concentration of 8.8 mg./l. The TLm was 10-12 ppm. For *Danio* sp., the TLm for zinc sulphate was 10.0 ppm. It was thought desirable to study the effect of calcium and magnesium salts to see if these could antagonize the effect of zinc and thus reduce its toxicity to fish. Calcium chloride at 200 ppm reduced the mortality of Bangkok strain by 100 to 75%, the hardness being 150 ppm (as CaCO<sub>3</sub>). In the case of *Danio* sp. and Ooty strain of *Cyprinus carpio* also 100% reduction in mortality was obtained under these conditions. Lloyd<sup>2</sup> also found that with rainbow trout, solutions containing zinc sulphate and calcium chloride were less toxic than those containing zinc sulphate and calcium carbonate. Magnesium sulphate at 200 ppm reduced the mortality only by 12-25%, the hardness being 119 ppm. At pH 9.1, zinc sulphate at 15 ppm had no toxic effect on Ooty strain of Mirror carp but at pH 5.0, a 60% mortality was noted. Similar results were noted with the Bangkok strain. Higher pH values seem to reduce the toxicity of zinc sulphate while lower pH values increase it.

The toxicity of zinc chloride was also investigated. The TLm for *Tilapia* was 10-15 ppm when the temperature was 25.8-28.5° C., dissolved oxygen 5.6-8.2 mg./l., the pH 7.1-7.5, free carbon dioxide 0.9-1.8 ppm and alkalinity 33.6-48.8 ppm (as HCO<sub>3</sub>). The LC<sub>100</sub> was 20-22 ppm. Calcium carbonate 100-200 mg./l. was not effective in reducing the toxicity of ZnCl<sub>2</sub> to *Tilapia*, but 200 ppm of calcium chloride reduced the toxicity by 75%. Increasing the oxygen content of the water to 12.3 mg./l.

reduced the mortality due to toxicant to 40%. It is interesting to note that despite the higher ambient temperatures of our environment, the lethal concentrations appear to be higher than those reported in literature<sup>3,4</sup> for temperate species. *Cyprinus carpio* and *Tilapia mossambica* appear to be suitable test animals for bioassay of toxicants and are easily handled and available in plenty throughout the year.

Freshwater Biol. Station, A. SREENIVASAN.  
Bhavanisagar (P.O.), R. SOUNDAR RAJ.  
Madras, March 5, 1963.

1. Doudoroff, P., *et al.*, *Sewage and Industr. Wastes*, 1951, 23, 1380.
2. Lloyd, R., *Ann. Appl. Biol.*, 1960, 48, 84.
3. Mackee, W., *California State Water Quality Criteria and Addendum*, 1952.
4. Doudoroff, P. and Katz, M., *Sewage and Industr. Wastes*, 1953, 25, 802.

## LONGIDORELLA XENURA N. SP. (NEMATODA: DORYLAIMOIDEA) FOUND AROUND APRICOT ROOTS IN ALMORA, NORTH INDIA

THREE females and four juveniles of a nematode species belonging to the genus *Longidorella* Thorne, 1939, were collected in May, 1963, from soil around roots of apricots, *Prunus armeniaca* L. in Almora (U.P.). Due to the peculiar shape of the tail, these represent a hitherto undescribed species for which the name *Longidorella xenura* n. sp. is proposed.

There exist certain discrepancies regarding the identity of the genus *Longidorella*. Thorne originally proposed this genus to accommodate the species *Longidorella parva* Thorne, 1939, which had a short body, long attenuated buccal spear and offset enlarged part of oesophagus. However, Goodey (1963) did not give much importance to the character of the oesophagus and considered all the nominal dorylaimid nematodes which had a short body and a long attenuated spear in *Longidorella*. Thorne's (in litt.) recent opinion on this subject indicates that a separate genus be erected for those *Longidorella*-type species which do not have an offset enlarged portion of the oesophagus. We do not agree with this view because *Heterodorus* Altherr, 1952 (synonymised with *Enchodelus* by Goodey, 1963), already exists.

*Longidorella xenura* N. SP.

Measurements.—3 females: Length = 0.69-0.75 mm.; a = 22-24; b = 2.8-2.9; c = 11-12; V = 59-61%.

Holotype female: Length = 0.69 mm.; a = 23; b = 2.8; c = 11.5; V = 60%.

**Description.**—Body short, plump, tapering at either extremities; assuming a ventrally arcuate position when relaxed by gentle heat. Head rounded, continuous with neck contour (Fig. 1). Amphidial pouches vase-shaped with distinct crescentic apertures located at the base of the lateral lips. Amphidial duct continued posteriorly to join the sensillar sac at about three labial-widths from anterior end (Fig. 1). Buccal spear attenuated, 44 microns long with equally long, rod-shaped extension (Fig. 2). Spear guiding ring single, located at about three labial-widths from anterior end. Anterior part of oesophagus short, cylindrical, narrow, enveloped by nerve ring a little behind base of spear extension. Posterior part of oesophagus enlarged, cylindroid, strongly muscular,  $96 \times 17 \mu$ , set off by constriction from anterior part (Fig. 2). Nucleus of dorsal oesophageal gland near anterior end of enlarged part of oesophagus. Oesophago-intestinal junction with a conoid-rounded valve.

Vulva a transverse slit. Reproductive system didelphic; ovaries reflexed. Intestine apparently 4-celled in circumference. Pre-rectum and rectum short, each about one anal-body-diameter long. Tail about three anal-body-diameters long, elongate-conoid, slightly bent dorsally (Fig. 3).

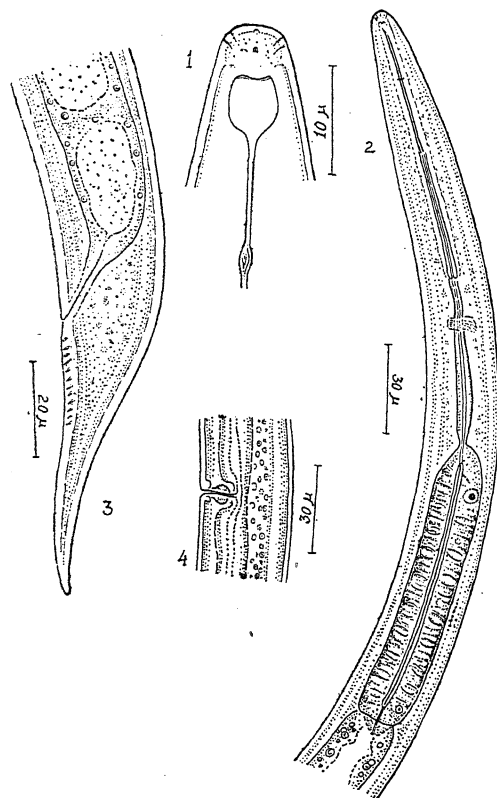
**Differential diagnosis:** *Longidorella* with the above measurements and general description, distinctive because of 0.69–0.75 mm. long body,  $44 \mu$  long spear, a long neck, vulva located at 59–61% of body and an elongate-conoid, dorsally bent tail. *L. xenura* n. sp. can easily be differentiated from all the known species of the genus *Longidorella* by having an elongate-conoid, dorsally bent tail.

**Type material.**—Holotype female, in Slide No. PN/D/5-001, deposited with the Zoology Museum, Aligarh Muslim University, Aligarh, India.

**Type habitat.**—Soil around roots of apricot, *Prunus armeniaca* L.

**Type locality.**—Near Central Jail, Almora (U.P.), India.

Department of Zoology, EKRAMULLAH KHAN,  
Aligarh Muslim University, M. RAFIQ SIDDIQI,  
Aligarh (India), June 10, 1963.



FIGS. 1-4. *Longidorella xenura* n. sp. Fig. 1. Anterior end of female showing amphidial system. Fig. 2. Oesophageal region of female. Fig. 3. Tail end of female. Fig. 4. Vulvar region of female.

1. Altherr, E., *Ergebn. Wissensch. Untersuch. Schweiz. Nat.-Parks*, 1952, 3 nF. (26), 315.
2. Goodey, J. B., Mathuen & Co., London, 1963.
3. Thorne, G., *Capita Zoologica*, 1939, 8, 1.

#### A HAEMATOXYLIN SQUASH TECHNIQUE FOR THE STUDY OF GRASSHOPPER CHROMOSOMES

THE adaptability of the haematoxylin squash technique<sup>1</sup> to a variety of modifications enabled the presentation of critical evidence for the presence of such debated structures like the limiting membranes for the nucleoli<sup>2</sup> and chromosomes<sup>3</sup> and to elucidate the SAT-configurations<sup>4</sup> and the structural details of the chromosomes themselves.<sup>5</sup>

Since similar problems remain unresolved in the meiotic chromosomes of grasshoppers,<sup>6-10</sup> an exploration of the suitability of the above technique to the male germinal tissue of *Pæcilocerus pictus* was considered desirable. The chromosome morphology alone is dealt with in the present communication.

*Pæcilocerus pictus* was available only during certain seasons of the year. The testes were dissected out in Ringer's solution, fixed in acetic alcohol (1:3) and stored in 70% alcohol. A hydrolysis in N HCl at 60° C. for 6 minutes

is optional. The material, with interpolated washes in distilled water, was mordanted in 4% ferric ammonium sulphate for 25-30 minutes and stained with a well-ripened 0.5% solution of hæmatoxylin (dark variety of Gurr) for 30 minutes. To study the nucleoli, the fixed material stored in 70% alcohol for about two months was exposed to 10% formaldehyde for 30 minutes and hydrolysed in N HCl at 60° C. for 60 minutes before staining.

The stained material washed well in water was teased into small bits in a drop of 45% acetic acid on a slide and then squashed under a coverslip. The observations made are from temporary as well as permanent preparations.

tive heteropycnosis, the preparations have to be stained lightly. The primary constriction<sup>7-8</sup> was observed in the small chromosome lying near the centre of the metaphase plate (Fig. 1). In rare instances, the primary constrictions were well defined in the chromosomes as shown in Fig. 2 (see Text-Fig. 7B of Dutt<sup>13</sup>). Compared to the autosomes, the staining of the slender X-chromosome was relatively lighter.

The nucleolus is seen in association with a pachytene bivalent in Fig. 3. The bivalents had fuzzy outlines. This lampbrush condition was better defined at diakinesis (Fig. 4). One of the bivalents is enlarged in Fig. 5 to reveal the details. The X-chromosome and the small



FIGS. 1-5. Fig. 1. Spermatogonial metaphase showing the 19 chromosomes,  $\times$  ca. 1,100. Fig. 2. Primary constrictions seen in several metaphase chromosomes,  $\times$  ca. 850. Fig. 3. Association of a nucleolus with a pachytene chromosome,  $\times$  ca. 2,200. Fig. 4. Diakinesis. Note the lampbrush fibres,  $\times$  ca. 850. Fig. 5. One of the bivalents in Fig. 4 enlarged to show the lampbrush fibres,  $\times$  ca. 3,000. A, Smallest autosomal bivalent; N, Nucleolus; X, X-Chromosome.

A spermatogonial metaphase showing the 19 chromosomes<sup>11-14</sup> is illustrated in Fig. 1. It is generally believed that the negative heteropycnosis of the X-chromosome is less pronounced, and may even be absent, in the last spermatogonial division.<sup>15</sup> Because the staining was deep, the X-chromosome was as deep as the autosomes in Fig. 1. To observe the nega-

autosomal bivalent (A) were positively heteropycnotic at diakinesis (Fig. 4), though the staining of the latter was relatively lighter. There appears to be a correlation between the grade of expression of the lampbrush condition and the degree of positive heteropycnosis. This is exemplified by the absence of the lampbrush fibres in the X-chromosome, their sparse

development in the heteropycnotic small bivalent (A) and the pronounced lampbrush condition of the other bivalents.

Cytogenetics Lab., (MISS) N. K. MANGALANGI.  
Dept. of Biochem., M. K. SUBRAMANIAM.  
Indian Institute of Science,  
Bangalore-12, May 20, 1963.

1. Marimuthu, K. M. and Subramaniam, M. K., *Curr. Sci.*, 1960, **29**, 482.
2. Royan, S., *Proc. Ind. Acad. Sci.*, 1962, **55 B**, 201.
3. Subramaniam, M. K. and Royan, S., *Curr. Sci.*, 1962, **31**, 227.
4. Meenakshi, G. and Subramaniam, M. K., *Proc. Ind. Acad. Sci.*, 1962, **55 B**, 15.
5. Subramaniam, M. K. and Subramanyam, S., *Curr. Sci.*, 1961, **30**, 172.
6. Makino, S., *J. Fac. Sci.*, Hokkaido Imp. Univ., 1936, **5**, 29.
7. Darlington, C. D., *Jour. Genet.*, 1936, **33**, 465.
8. Coleman, L. C., *Genetics*, 1943, **28**, 2.
9. Ris, H., *Biol. Bull.*, 1945, **89**, 242.
10. Hsu, T., *Jour. Genet.*, 1948, **48**, 311.
11. Asana, J. and Makino, S., *Jour. Univ. Bombay, Biol. Sci.*, 1934, **2**, 50.
12. Rao, T. R., *J. Morph.*, 1937, **61**, 223.
13. Dutt, M. K., *Proc. Zool. Soc. Bengal*, 1955, **8**, 111.
14. Srivastava, M. D. L., *La Cellule*, 1960, **61**, 67.
15. White, M. J. D., *Jour. Genet.*, 1940, **40**, 67.

### EFFECT OF INOCULATION OF *AULOSIRA FERTILISSIMA* ON RICE PLANTS

THE favourable effect of algal inoculation upon the growth and yield of rice plants has been well demonstrated and documented.<sup>1-7</sup> The large-scale field experiments with *Tolypothrix tenuis* showed a progressive increase in the yield of rice and also indicated that the inoculation had actually a favourable effect in enhancing the fertility of the paddy soils.<sup>6</sup> Singh<sup>4</sup> reported an increase in the yield of paddy (T 9) over the control by 368% in pots and by 114% under the field conditions, due to the inoculation with *Aulosira fertilissima*.

The present note gives the results of the inoculation experiments with *Aulosira fertilissima*, using sand culture pot (10 lb. capacity) experiments. Four treatments were set up with six replications in each, viz., (A) control, (B) algal series, (C) ammonium sulphate (44.6 Kg./hectare) series and (D) ammonium sulphate plus algal series. The algal series were inoculated with 100 ml. of a uniform suspension of the alga, containing 0.122 gm. (dry wt.) alga per pot. Each pot was planted with six one-month-old seedlings of rice plants (NP 130) initially, which were later thinned to four. The

pots were regularly watered with nitrogen-free Hoagland medium.

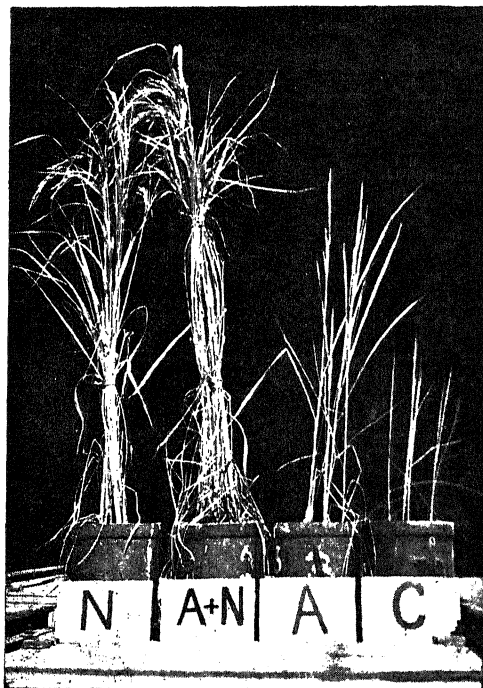


FIG. 1. Effect of inoculation of *Aulosira fertilissima* on the growth of rice plants (C, control; A, alga; N, ammonium sulphate; A+N, ammonium sulphate and alga).

TABLE I  
Effect of inoculation of *Aulosira fertilissima* on the average yield of paddy (NP 130) and percentage of nitrogen in the straw and grain

Treatments	Straw (gm.)	Paddy (gm.)	Rice (gm.)	% N in straw	% N in rice
A. Control	1.18	0.58	0.28	0.43	1.19
B. Alga	2.97	2.13	1.2	0.65	1.38
C. Ammonium sulphate	12.22	4.90	3.57	0.71	1.75
D. Ammonium sulphate and alga	21.97	14.46	11.32	0.77	1.87
C.D. at 1%	9.78	1.33	2.85	0.034	0.113
" 5%	7.22	..	2.10	..	..
Comparing A and B	12.03	..	6.00	..	..
t (Significant at 1%)					

As may be seen from Table I, the inoculation of *Aulosira fertilissima* resulted in an increase in the yield of paddy by 266% and of rice by 323% over the control. Besides, it may also be

noted that the combination of ammonium sulphate and alga increased the yield of paddy by about 195% and of rice by about 217% over the series treated with ammonium sulphate alone. However, the increase in the percentage nitrogen in the straw in the former was only about 8% over the latter, while in the algal series (treatment B), the increase was about 46% over the control. The percentage nitrogen in the rice grains in the algal series increased by about 16% over the control, while the difference between treatments C and D was not significant. This suggests that in the presence of ammonium sulphate at the rate of 44.6 Kg./hectare, the contribution of the alga towards nitrogen alone may not be the only factor to account for the increase in the yield. Possibly, some growth-promoting substance(s) might also be produced by the alga, which might activate the growth of the crop. This aspect is being investigated. There was also no marked difference in the free amino acid composition of the straw between the treatments, although in the control the concentration of all amino-acids, except alanine and valine, were considerably lower.

We record our grateful thanks to Dr. B. P. Pal, Director, for his encouragement.

Div. of Microbiology, W. V. B. SUNDARA RAO,  
Indian Agric. Res. Inst., S. K. GOYAL,  
New Delhi-12, G. S. VENKATARAMAN.  
January 3, 1963.

1. Allen, M. B., *Nat. Magaz.*, 1966, **83**, 100.
2. De, P. K., *Proc. Roy. Soc. London*, 1939, **127 B**, 121.
3. and Sulaiman, M., *Indian J. Agr. Sci.*, 1950, **20**, 327.
4. Singh, R. N., *Release Blue Green Alga in Nitrogen Economy of Indian Leguminosae*, Indian Council of Agricultural Research, New Delhi, 1961, pp. 175.
5. Venkataraman, G. S., *Sci. and Tech.*, 1961, **27**, 9.
6. Matamoros, A., *Legum. appl. Microbiol. Tokyo*, 1962, **8**, 85.
7. , Nigamdi, S. and Korihi, G., *Nature*, 1961, **168**, 748.

#### A NEW SPECIES OF SEPTORIA ON AN ECONOMIC HOST

A severe leaf-spot disease of the pulse crop *Vigna sinensis* (L.) Endl. (Chavli) was noticed during the monsoon of 1961 and 1962 in and around Poona causing severe damage. Diseased lesions revealed presence of abundant pycnidia with filiform, septate, hyaline pycnidiospores, characteristic of the genus *Septoria*. So far only one valid species of *Septoria* seems to have been reported from *Vigna* sp. (Saccardo, 1913). The Poona species was, therefore, critically com-

pared with *S. vignae* P. Henn., the results of which are presented in Table I.

TABLE I  
Comparison of spp. of *Septoria* reported from *Vigna* species

Fungus	Host	Pycnidia (diam. in $\mu$ )	Pycnidiospores in $\mu$	Authority
<i>Septoria Vigna</i> P. Henn.	<i>Vigna</i> sp.	50-70	3-septate 25-35 $\times 1.0$	P. Henn. (Sacc. 1913, <b>22</b> , 1096)
Poona sp.	<i>Vigna sinensis</i> (L.) Endl.	63-113.4	2-4-septate 21-67.2 $\times 1.26$ - 2.1	

It is clear that the Poona collection of *Septoria* is significantly distinct in morphological characters. It is described as a new species:

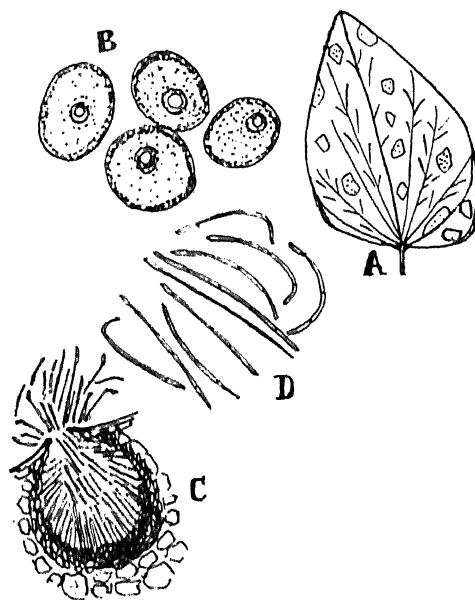


FIG. 1. A, Symptoms,  $\times \frac{1}{2}$  Nat size; B, Pycnidia,  $\times 100$ ; C, Pycnidium in section,  $\times 150$ ; D, Pycnidiospores,  $\times 792$ .

*Septoria vignicola* VASANT RAO, SP. NOV.

Infectionis maculae epiphyllae, angulares, dispersae, lateritiae vel rubro-brunneae. Pycnidia rara in singulis maculis, epiphylla, dispersa, altiora in textibus plantae hospitis, ex sphaericis globoidea, ostiolata, crassis parietibus, alte brunnea, 63-113.4  $\mu$  diam. Sporae filiformes, 2-4 septatae, vulgo 3-septatae, hyalinae, nonnullae curvatae, flexuosae, 21-67.2  $\mu$  longae, 1.26-2.1  $\mu$  latae.

In foliis viventibus *Vignae sinensis* (L.) Endl.  
leg. Vasant Rao ad Poona (India), mense  
augusto 1962, M.A.C.S. No. 141.

The types are being deposited at the Herb.  
Crypt. Orient, New Delhi (India) and C.M.I.,  
Kew, England.

The author's thanks are due to Prof. M. N.  
Kamat for guidance, to Dr. H. Santapau for  
Latin diagnosis, to U.G.C., New Delhi, for  
awarding a Junior Research Fellowship and to  
Director, for facilities.

M.A.C.S. Labs., VASANT GURUNATH RAO.  
Poona-4, January 12, 1963.

1. Saccardo, P. A., *Sylloge Fungorum*, 1913, 22, 1096.

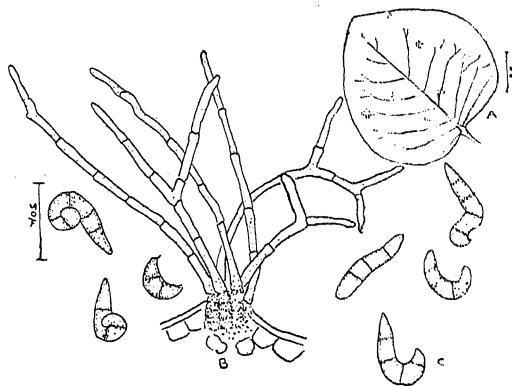


FIG. 1. A—Habit; B—Conidiophores. C—Conidia.

TABLE I  
Comparison between species of *Helicospira*

Species	Conidiophores	Conidia	Authority
<i>H. caperona</i> Olive ..	Branched, 2-12 septate, 92-329 × 4-6.6 μ	Brown, 1-7 septate, coiled, 17.4-40 × 4.5-6.3 μ	Olive, 1948
<i>H. indica</i> Subr. ..	Simple, 144 × 4.2-6.0 μ	20-57.8 × 5.7-10.2 μ	Subramanian, 1956
<i>H. costi</i> Salam and Rao	Simple, straight, dark brown, 270-414 × 4.8 μ	Light brown, 1-9 septate, 27.2-72.0 × 6.4-7.2 μ	Sakum and Rao, 1958
<i>H. species</i> (Poona) ..	Deeply bifurcated, much branched, wavy, subhyaline, 4-6 septate, 78.75-378.2 × 4.1-6.8 μ	Subhyaline, 2-4 septate, curved to coiled, 38.5-102.5 × 8.2-11 μ	..

### *HELICOSPORA POONENSIS* SP. NOV. FROM INDIA

In the course of their collection work for new  
fungi in and around Poona, the writers noticed  
a few vines of *Argyrea speciosa* Sweet in the  
Empress Botanical Gardens, Poona, showing  
infection spots on living leaves and sometimes  
on young tender stems. These spots were cir-  
cular, brown, widely scattered, many per leaf,  
often causing extensive necrosis with hypophyl-  
lous fruiting bodies in the form of dense ash-  
coloured overgrowth of a fungus, which, on  
examination, was identified as a species of  
*Helicospira* Olive. The genus *Helicospira* Olive  
was established by Olive (1948) for a parasitic  
*Helicosporeus* Hyphomycetes with branched  
conidiophores, distinguishing it from the earlier  
genus *Helicoma* Corda for a saprophytic dark  
brown fungus with simple unbranched conidio-  
phores. On this basis, the Poona species,  
being parasitic and possessing much branched  
conidiophores is, therefore, identified as a  
species of *Helicospira* Olive. A careful search  
for literature showed that ever since the genus  
was established by Olive (1948), only two other  
species of this *Helicosporeus* Hyphomycetes have

been described both from India, viz., *H. indica*  
Subr. by Subramanian (1958) collected on an  
unidentified species of legume and the other  
*H. costi* Salam and Rao (1958) associated with  
*Piricularia* leaf-spots on *Costus speciosa* Sm.  
from Hyderabad-Dn. The Poona fungus was,  
therefore, carefully studied and compared with  
the three previously described species with the  
following results (Table I).

The Poona species is thus distinct from either  
the type or the other two Indian species in  
respect of both morphological characters, and  
dimensions of conidiophores and conidia, besides  
being parasitic and inciting extensive folliculose  
infection independently. *H. indica* Subr. is a  
distinct species in having significantly smaller  
dimensions of conidiophores and conidia. The  
Poona species on the other hand while agreeing  
with the type in respect of conidiophores, has  
significantly bigger conidia. On the other hand,  
it is distinct from *H. costi* Salam and Rao in  
being subhyaline all through, having much  
branched deeply forked conidiophores and bigger  
and broader conidia. Besides it has been  
collected on a hitherto unreported host.

It is, therefore, proposed to accommodate the  
Poona species in a separate taxon and

described as a new species with Latin diagnosis :

*Helicomicina poonensis* SP. NOV. K. R. GOPINATHAN  
NAIR AND T. RAGHUNATH

Infection spots amphigenous, brown, widely scattered, many per leaf, circular, up to 20 mm.

Conidiophores hypophyllous, simple to deeply forked fasciculate (5-9 in number), divergent, 4 to 6-septate, constricted, placed on a poorly developed stroma, subhyaline,  $78.75-378.2 \times 4.1-6.8 \mu$ .

Conidia bent to curved, often coiled, subhyaline, 2-4 septate, rarely up to 9-septate, non-constricted, with a basal hilum,  $38.5-102.5 \times 8.25-11.0 \mu$ .

Inciting leaf-spots and blight on *Argyreia speciosa* Sweet collected by K. R. Gopinathan Nair and T. Raghunath in September 1962 at Poona (India), M.A.C.S. No. 154 (Type).

*Helicomicina poonensis* SPEC. NOV. K. R.  
GOPINATHAN NAIR AND T. RAGHUNATH

Infectionis maculae amphigenae, brunneae, late dispersae, plures in singulis foliis, circulares, usque ad 20 mm. Conidiophori hypophylli, simplices vel alte furcati, fasciculati (5-9) divergentes, 4-6-septati, constricti, siti in stromate pauperrime evoluti, subhyalini,  $78.75-378.2 \times 4.1-6.8 \mu$ . Conidia flexa vel curvata, saepe spiraliter curvata, subhyalina, 2-4 septate, rarius ad 9-septata, non-constricta, hilo basali ornata,  $38.5-102.5 \times 8.25-11.0 \mu$ .

Producit maculas in foliis *Argyreiae speciosae* Sweet. Leg. K. R. Gopinathan Nair and T. Raghunath, Sept. 1962, Poona in India, M.A.C.S. No. 154 (Type).

This is the third record described from India and the fifth in the world, besides being an addition to the Bombay Fungi.

The type specimens are being deposited at the Herb. Orientalis, New Delhi, India, and Commonwealth Mycological Institute, Kew, England.

Grateful thanks are offered to Prof. M. N. Kamat for his deep interest and guidance, to Dr. G. B. Deodikar for laboratory facilities and to Prof. H. Santapau for Latin diagnosis.

M.A.C.S. Laboratories, K. R. GOPINATHAN NAIR.  
Poona-4 (India), T. RAGHUNATH.  
January 29, 1963.

1. Olive, Lindsay, S., *Mycologia*, 1948, **40**, 6.
2. Subramanian, C. V., *J. Indian bot. Soc.*, 1950, **35**, 53.
3. Salam, M. A. and Rao, P. N., *Indian Phytopath.*, 1958, **11**, 121.

## INTERCHROMOSOME DISTRIBUTION OF CHIASMATA IN ANNUAL CHRYSANTHEMUM

ALTHOUGH interchromosome effects for chiasma formation have been reported in a number of organisms, their significance has not been fully understood primarily because of their variable nature both at inter and intraspecies levels.<sup>1-3</sup> More recently however it has been found that the different plants of *Delphinium ajacis* are remarkably consistent in showing negatively correlated chiasma formation in their chromosomes.<sup>4,5</sup> The present brief report relates to another plant in which the interchromosome correlation for chiasmata tends to be consistently of the positive type. It is obvious that finding of organisms which invariably show a particular type of interchromosome effect and differ from one another with regard to its direction can be of considerable help in analysing the factors controlling the interchromosome distribution of chiasmata.

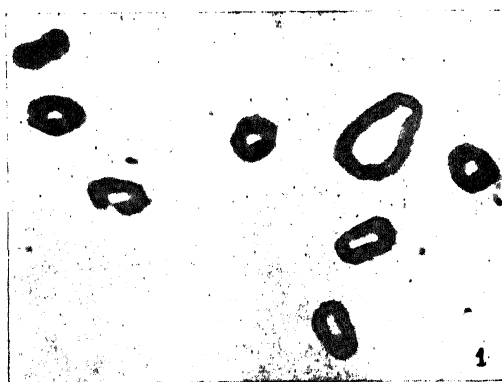


FIG. 1. Pollen mother cell at prometaphase showing an interchange multiple of four chromosomes and seven bivalents,  $\times 2,880$ .

The nine pairs of chromosomes in structurally homozygous plants of annual chrysanthemum (*Chrysanthemum carinatum*) do not show such size differences as will make it possible to distinguish some of the bivalents from others. A number of interchange heterozygotes, however, were available from a previous study in which it was found possible to separate the chromosomes into two groups of 4 and 14 chromosomes; chromosomes of the first group forming the interchange. multiple, those of the second appearing in the form of 7 bivalents (Fig. 1). Fifteen such plants were analysed for the frequency of chiasmata in the two groups of chromosomes at metaphase I. The cytological

technique employed and the method of analysing the observations have been described in an earlier paper.<sup>4</sup> The method involved the determination of internuclear variance which measures the variation in the total number of chiasmata among the pollen mother cells, and inherent variance (redesignated as intranuclear variance) which provides a measure of variation in the number of chiasmata between the two groups of chromosomes in individual cells. The observations on mean chiasma frequency and the estimates of two variances are presented in Table I. It will be seen from this table

TABLE I

## Analysis of variance of chiasma frequency

Plant no.	Mean chiasmata per cell	Internuclear variance	Intranuclear variance	Correlation
1	14.30	0.6000	0.3448	++
2	14.04	0.1875	0.1838	++
3	14.36	0.2565	0.1342	+
4	14.93	0.3924	0.1322	++
5	14.40	0.2113	0.1308	++
6	15.10	0.2931	0.1068	++
7	16.23	1.3768	0.3889	++
8	16.46	0.5710	0.4896	++
9	18.00	1.0030	0.1989	++
10	15.10	0.3703	0.2120	++
11	15.30	0.3993	0.1503	++
12	15.76	0.4189	0.1412	++
13	15.13	0.5113	0.0941	++
14	15.13	0.4041	0.1351	++
15	15.33	0.2324	0.1303	++

† Correlation positive, significant at 1% level.

\* Correlation positive, significant at 5% level.

‡ Correlation not significant.

that for each of the 15 plants, the internuclear variance exceeds the intranuclear, thus indicating a tendency for positively correlated chiasma frequencies in the two groups of chromosomes. A statistical analysis shows that in nine of the plants, the difference in the magnitudes of the two variances is highly significant, which confirms the positive correlation in these plants.

The negative interchromosome correlation for chiasma formation has been considered by Mather<sup>1</sup> to be a function of an upper limit on chiasma formation in a nucleus. Interchromosomal effects for genetic recombination in *Drosophila* have likewise been interpreted as indicating the availability of a fixed amount of energy for crossing over.<sup>6</sup> If the negative correlation is indicative of a tendency to limit the number of chiasmata, a positive correlation of the type observed in annual chrysanthemum suggests a mechanism which ensures maximization of crossing over in the nucleus. Stebbins,<sup>7</sup> among others, has discussed how the recombination

index has been selected to favour a greater or lesser release of genetic variability in different types of populations. The analysis described by this author in the family *Compositae* indicates that changes in the recombination index constitute an important part of the process of adaptive alterations of the genetic system. In view of these considerations, it may be supposed that the negative and positive types of interchromosome distribution of chiasmata reflect such differences of the genetic system in different organisms.

The fact that all the fifteen plants, although differing in their mean chiasma frequency, either show or indicate a tendency for a particular type of interchromosomal correlation is of further interest from the point of view of analysis of the mechanisms which ensure a positive correlation in the present case and a negative one in plants like larkspur. As a first step towards such analysis, it is proposed to confirm the consistent nature of the positive correlation in *Chrysanthemum* through a more comprehensive study.

We are grateful to Dr. B. P. Pal and Dr. M. S. Swaminathan for their interest in this study.

Botany Division, SUDHA BHATNAGAR.  
Indian Agric. Res. Institute, H. K. JAIN.  
New Delhi, January 31, 1963.

1. Mather, K., *P.R.S.*, 1936, **120 B**, 208.
2. Rowlands, D. G., *Chromosoma*, 1958, **9**, 176.
3. Elliot, C. G., *Heredity*, 1958, **12**, 429.
4. Jain, H. K. and Maherchandani, N., *Ibid.*, 1961, **16**, 383.
5. Basak, S. L. and Jain, H. K., *Chromosoma*, 1963, **13**, 577.
6. Swanson, C. P., *Cytology and Cytogenetics*, Prentice-Hall, Inc., Englewood, U.S.A., 1957, pp. 252.
7. Stebbins, G. L., *C.S.H.S. Quant. Biol.*, 1958, **23**, 365.

### FUNCTIONAL MALE-STERILITY IN *BRASSICA CAMPESTRIS* VAR. BROWN SARSON

In five varieties of brown sarson (*Brassica campestris* var. brown sarson), Das and Pandey<sup>3,4</sup> reported genic male-sterility where the anthers were small, pointed and contained no viable pollen grains. This note records another case of male-sterility in brown sarson where the anthers were normal-looking but did not dehisce. This was observed in 1960-61 in a few plants arising from a cross between M-18 and variety A of brown sarson. There was no morphological difference between the plants with normal (dehiscent) and non-dehiscent anthers



TABLE I

Segregation in  $F_2$  of crosses between non-dehiscent  $\times$  dehiscent anthers; also included are the  $S_1$  data of the male parents used in the crosses

Crosses (1960-61)	$F_1/S_1$ Plant number (1961-62)	$F_2$ family (1962-63)	Segregation		$\chi^2$ (3:1)	P
			Normal	Non-dehiscent		
P607-5ND $\times$ P690-1	B121-3 $\otimes$	B177	33	10	0.0697	0.70
	B121-8 $\otimes$	B423	20	8	0.1904	0.50
P608-2ND $\times$ P686-1	B122-1 $\otimes$	B136	46	18	0.3333	0.50
	B122-2 $\otimes$	B167	13	4	0.0196	0.80
P608-8ND $\times$ P544-3	B123-5 $\otimes$	B428	84	24	0.4444	0.50
	B123-7 $\otimes$	B178	56	18	0.0180	0.80
Male parents P544-3 $\otimes$	B66	..	51	0	..	..
P686-1 OP	B119	..	41	0	..	..
P690-1 $\otimes$	B120	..	32	0	..	..

except that anthers of the latter type protruded out of the flowers for a longer duration while the anthers of the normal flowers were shrivelled as soon as the pollen grains were liberated after dehiscing. The pollen grains of the non-dehiscent anthers were not liberated but stained well with acetocarmine indicating thereby that they were normal. No pollen grains were seen on the outside of the non-dehiscent anthers while some yellowish pollen dust was found on the outer surface of the dehiscent anthers. The non-dehiscent anthers dried up after 2-3 days of flowering and finally fell off without liberating the pollen grains. Such functional male-sterility has also been found in other crops as ragi,<sup>1</sup> maize,<sup>2</sup> tomato,<sup>7</sup> cotton<sup>6,8</sup> and brinjal.<sup>5</sup>

These functional male-sterile plants, when crossed with plants possessing normal dehiscent anthers, produced all normal plants in  $F_1$ . The  $F_2$  progeny segregated into 3:1 ratio (Table I) indicating a monogenic inheritance of normal (dehiscent) versus non-dehiscent anthers with dehiscence dominant over non-dehiscence. Such monogenic inheritance of functional male-sterility was observed in *Eleusine coracana*<sup>1</sup> and maize.<sup>2</sup>

College of Agriculture, K. DAS.  
Banaras Hindu University, J. B. CHOWDHURY.  
February 4, 1963.

1. Ayyangar, G. N. R., *Ind. J. Agric. Sci.*, 1931, **1**, 554.
2. Beadle, G. W., *Genetics*, 1932 **6**, 17, 413.
3. Das, K. and Pandey, B. D., *Ind. J. Genet. and Pl. Br.*, 1961 **a**, 21, 185.
4. — and —, *I.C.O.C. Proc. Sec. Oilseeds Work Conf. Madras*, 1961 **b**, 1961.
5. Jasmin, J. J., *Proc. Amer. Soc. Hort. Sci.*, 1954, **63**, 443.

6. Joshi, A. B. and Patil, B. D., *Curr. Sci.*, 1960, **29**, 63.
7. Larson, R. E. and Paur, S., *Proc. Amer. Soc. Hort. Sci.*, 1948, **52**, 355.
8. Sikka, S.M., Swaminathan, M. S. and Jagatheesan, D., *Ind. J. Genet. and Pl. Br.* 1956, **16**, 144.

#### SOME RESULTS OF BREEDING AJWAIN, *TRACHYSPERMUM AMMI* (L.) SPRAGUE, FOR HIGH ESSENTIAL OIL CONTENT

*Ajwain*, *Trachyspermum ammi* (L.) Sprague (syn.) *Carum copticum* Benth. et Hooker is one of the important essential oil-bearing spice crops of India and is a principal organic source of the drug thymol.

During the intensive screening of a large collection of indigenous and exotic material of *ajwain* built up at this Institute, it was discovered that the essential oil content in the seed normally ranged between 3 and 5%, except in one collection from Hubli in Mysore State (Accession No. I.C. 3819). Several individual plants of this collection were found to have essential oil content, ranging between 7 and 10%. Selection for high yield and essential oil content has resulted in the establishment of the following cultures which have, for over three generations of selfing and isolation, maintained high values of essential oil content (Table I).

During 1959-60 and 1960-61 the seed material of these cultures was increased for further tests which were carried out on the crop grown in 1961-62.

A point of interest is that, although the values for essential oil content were relatively lower

TABLE I

Performance of the parental collection (I.C. 3819) and of the selections therefrom with reference to essential oil content

		Essential oil content %			
		1956-57	1957-58	1958-59	1961-62*
Parental collection					
I. C. 3819	..	7.7			
Local material	..	3.0			
N.P. (P) 151	..	9.78	8.58	8.28	
N.P. (P) 152	..	9.48	8.88	6.48	
N.P. (P) 153	..	7.88	9.08	6.64	
N.P. (P) 155	..	9.58	8.18	6.28	

\* Plants grown at Delhi; other columns relate to plants grown at Pusa (Bihar).

in the Delhi-grown material (1961-62) than at Pusa (Bihar), all the four selections mentioned above maintained markedly high values in respect of essential oil content. Selection No. 151 appeared to be the least affected by the changed environment and could be expected to give similar performances over a wider range of habitat.

It may also be mentioned in this connection that N.P. (P) 151 also combined high yielding ability with high essential oil content. It significantly outyielded the local on an average of two years' data (1958-59 and 1959-60) by 147%. During 1958-59, it gave a yield of 0.66 kg. per plot ( $6.7 \times 1.8$  metres) as compared to 0.43 kg. given by the local control; the yield figures per plot ( $6.1 \times 3.0$  metres) during 1959-60 N.P. (P) 151 and the control were 3.35 kg. and 2.38 kg. respectively.

The authors are thankful to the Head of the Division of Soil Science and Agricultural Chemistry and to Dr. K. C. Gulati, Professor of Agricultural Chemistry, for facilities and co-operation in this project and to the Indian Council of Agricultural Research for financing the scheme.

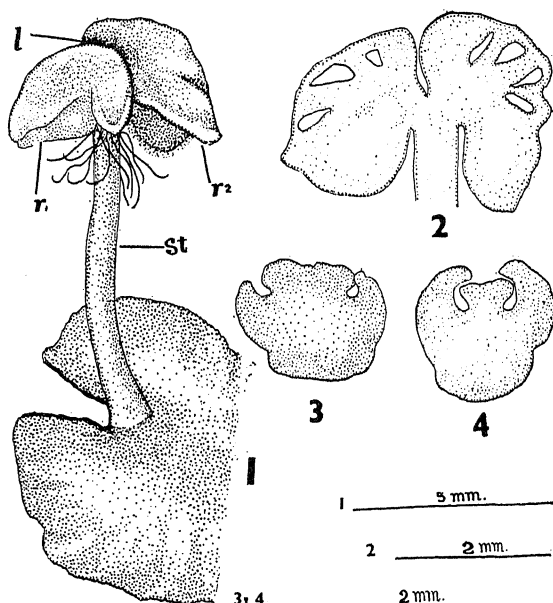
Indian Agri. Research Institute, M. G. JOSHI.  
New Delhi, February 18, 1963. A. B. JOSHI.

1. Anonymous, *Hart Court Butler Tech. Bull.* (Revised), 1958.
2. Joshi, A. B., *Indian Fmg.*, 1961, 10 (10), 24.
3. Sadgopal, *Indian Forester*, 1957, 83 (6), 355.

# ON THE OCCURRENCE OF COMPOUND FEMALE RECEPTACLES IN *REBOULIA HEMISPHAERICA* (L.) RADDI

AN examination of the collection of *Reboulia hemisphaerica* from Kodaikanal, Madras State, South India, led to the interesting discovery of some plants having compound female receptacles. Normally the female receptacle of *Reboulia* consists of a convex, 4-9-lobed disc attached to the thallus with a long stalk having single rhizoidal furrow extending from apex to base. The receptacular scales are conspicuous and linear.

A large number of plants found have their receptacles divided in two parts, each part assuming the shape of a more or less normal receptacle (Fig. 1,  $r_1$ ,  $r_2$ ). There is a distinct separating line (Fig. 1,  $l$ ; Fig. 2) between the two parts of the receptacle in each case. These specimens vary in the degree of attachment between the two receptacles and the reduction in the number of the lobes and involucre. The compound receptacle is attached with a stalk (Fig. 1,  $st$ ), in all cases, having two rhizoidal furrows (Figs. 3, 4) extending from apex to the base. The anatomical features of the receptacles and the thallus are quite normal.



FIGS. 1-4. Fig. 1. Thallus with a compound female receptacle.  $r_1$ ,  $r_2$ : two parts of the receptacle;  $l$ , separating line;  $st$ , stalk. Fig. 2. L.S. of the female receptacle showing the two parts. Fig. 3. T.S. of stalk at apex. Fig. 4. T.S. of the same at base. Note the presence of two rhizoidal furrows.

The discovery of the compound female receptacles having two rhizoidal furrows in their stalks suggests the phyletic line which led to the evolution of *Reboulia* from *Marchantia* or *Marchantia*-type ancestors, having two or more rhizoidal furrows in the stalks of their female receptacles.

I am grateful to Dr. Ram Udar for his guidance in the preparation of this paper.

Botany Department, VINOD CHANDRA.  
Lucknow University,  
Lucknow, February 13, 1963.

# POLLEN MORPHOLOGY OF TWO INDIAN SPECIES OF *BALANOPHORA* FORST

INFORMATION regarding the pollen morphology of *Balanophoraceae*—a family of root parasites of tropical and sub-tropical areas—is available from the works of Erdtman (1952), Ikuse (1956) and Zinderen Bakker (1953).

Though several other genera belonging to the family have been described by the above authors, the only information relating to the pollen grains of the genus *Balanophora* is from the work of Erdtman (1952) who mentions the occurrence of three porate grains in *Balanophora elongata* (Buitenzorg) and *B. polyandra* (Sikkim), where the grains are not square in equatorial view.

The present study refers to the two common species, viz., *Balanophora indica*, Wall and *Balanophora dioica*, R. Br., which occur in South India at altitudes from 1,000-2,000 metres and the material under study was collected from Kodaikanal and Naduvattam (Nilgiri Hills). The pollen for study from mature anthers is prepared by acetolysis and chlorinated and the measurements given below are for acetolysed chlorinated grains.

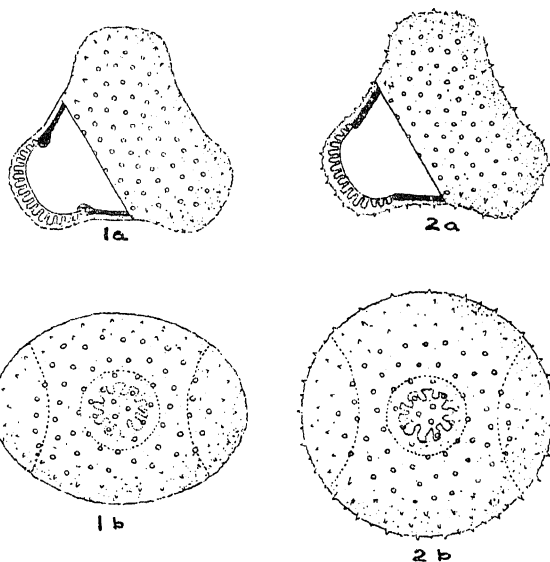
*Balanophora dioica*, R. BR. (FIG. 1)

Pollen triporate: They are isopolar, radio-symmetric, prolate, triangular in polar view, two-lobed in equatorial view. Equatorial axis:  $19.2\mu$ ; Polar axis:  $19.2\mu$ . Pores elliptic and large provided with slight costae, Operculum with very thick sexine.

Thickness of Exine— $1.6\mu$ . Surface pattern very faint. Nexine is thicker near the pores and thinner in between the pores.

*Balanophora indica*, Wall (Fig. 2) differs from the previous species slightly in the following characters but the differences are nevertheless significant. The pollen grains are

triangular. Equatorial axis:  $27.2\mu$ ; Polar axis:  $22.4\mu$ . Operculum with thick margin, that is irregular. Exine thickness— $1.6\mu$ ; Exine slightly echinulate—spines about  $1\mu$  long. Nexine without costae.



FIGS. 1-2. Fig. 1. *Balanophora dioica*. (a) Polar view,  $\times 1,500$ ; (b) Equatorial view,  $\times 1,500$ . Fig. 2. *Balanophora indica*. (a) Polar view,  $\times 1,500$ ; (b) Equatorial view,  $\times 1,500$ .

My sincere thanks are due to Prof. Ph. Guinet of the French Institute, Pondicherry, for a critical perusal of the manuscript and material and for his valuable suggestions in the preparation of this paper.

Botany Department, T. SESHAGIRI RAO.  
S.K.B.R. College,  
Amalapuram, February 15, 1963.

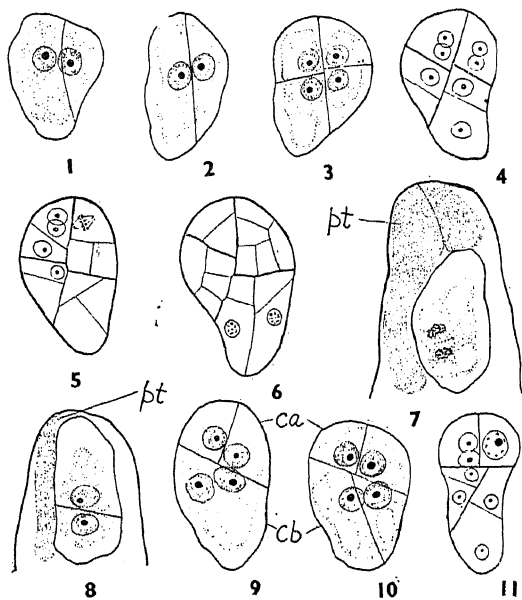
1. Erdtman, G., *Pollen Morphology and Plant Taxonomy—Angiosperms*, Stockholm, 1952.
2. Ikuse, M., *Pollen Grains of Japan*, Tokyo, 1956.
3. Zinderen Bakker, E. M. Van, *South African Pollen Grains and Spores*, Part 1, Cape Town, 1953.

## TWO TYPES OF EMBRYO DEVELOPMENT IN *PASSIFLORA FOETIDA* LINN.

In the majority of angiosperms the first division of the zygote is transverse but in a few cases it is known to take place in a longitudinal direction. This difference in the orientation of the first wall was considered quite significant by Johansen<sup>1</sup> (1950) who constituted a separate type of embryo development, known as the Piperad type, for those cases in which the first

division of the zygote is longitudinal. During the course of investigation on the embryology of *Passiflora foetida* Linn., it was noticed that the first division of the zygote in this species takes place in both the planes in sharp contrast to what is seen in other angiosperms.

The fertilized egg undergoes a period of rest and divides only after a large number of endosperm nuclei are formed in a free nuclear manner in the peripheral layer of the cytoplasm. In about 70% of the ovules the first division of the zygote is longitudinal or somewhat oblique forming two juxtaposed cells (Figs. 1, 2). Each one of them divides further transversely forming an isobilateral tetrad of the proembryo (Fig. 3). The development of the embryo (Figs. 4-6) subsequently follows the Piperad type of Johansen (1950).



FIGS. 1-11. *Passiflora foetida* Linn. Various stages in the development of the embryo. For details see text (pt, pollen tube),  $\times 900$ .

In the remaining 30% of the ovules the first division of the zygote is transverse (Figs. 7, 8) resulting in two superposed cells *ca* and *cb* (Fig. 8) which in turn divide vertically or nearly vertically (Figs. 9, 10) forming again, as in the previous case, an isobilateral tetrad of the proembryo. Obviously therefore such type of embryo development (Fig. 11) cannot be said to follow the Piperad pattern. The species of *Passiflora foetida* thus show two distinct types of embryo development. Possibly this is correlated with the initial organization of

the proembryonic tetrad. The details will appear elsewhere.

I am grateful to Dr. L. B. Kajale for helpful suggestions. Thanks are also due to Dr. K. Subramanyam for his kind interest and to Principal Rev. Father A. J. Malin for research facilities.

Dept. of Botany,

St. Francis de Sales' College,

Seminary Hills, Nagpur, February 6, 1963.

M. D. PADHYE.

1. Johansen, D. A., *Plant Embryology*, Waltham, Mass., U.S.A., 1950.

#### STUDIES ON THE CHROMOSOME NUMBER AND SPERMATOGENESIS IN THE LAC INSECT, *LACCIFER* *LACCA* (KERR)

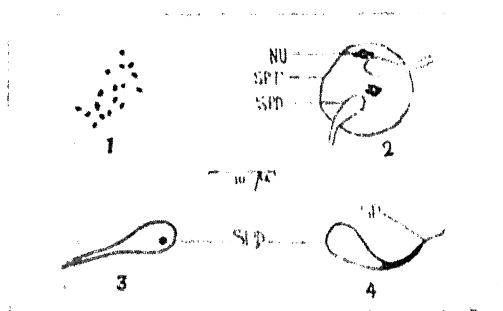
INVESTIGATIONS on the chromosomal cytology of the lac insect, *Laccifer lacca* (Kerr) (Family Lacciferidae), have been in progress for some time past, as a result of which the chromosomal complement of the somatic cells of this insect has been successfully worked out (Bose and Tulsyan, 1962 and Dikshit, 1962). The present studies had been undertaken to determine the chromosomal complement of the male, as well as to make observations on the process of spermatogenesis, on which very little is known at present.

Males of the *agahni* crop of the *Kusumi* strain were dissected at various larval stages in the medium of physiological salt solution; the testes were fixed in 3 : 1 aceto-alcohol, kept overnight in rectified spirit and finally squashed in acetocarmine. Histological preparations of entire male larvae (of all stages) were made after fixation in Carnoy's or Bouin's fixatives and staining in Iron Haematoxylin and Orange G.

The testes are first noticeable in the second larval stage where they are continued behind into the seminal vesicle of their respective side as fine duct-like structures. The seminal vesicle in the later stages of development (the pseudo-pupal stage) appears to function as the testis proper with the migration of the testicular contents into it. The testes proper are cast off at this stage. Accessory glands have not been noted at any stage.

In cross-section the testes are seen to be comprised of cysts of eight spermatogonial cells enveloped in a thin non-cellular layer. The group of eight spermatogonia with their diploid chromosomal complement undergo the usual divisions until finally 32 binucleate secondary

spermatocytes are formed, each nucleus containing the haploid set of chromosomes. Two spermatid bodies are now clearly distinguishable within the secondary spermatocyte. The haploid nuclei pass into the two spermatid bodies and after separation of the latter migrate into their cytoplasmic anlage which later detach to form individual motile sperms (Figs. 2-4). The spermatozoa form a bundle of their own and are bound together by means of thread-like structures, probably a few spermatozoa. In males the chromosome number is 17 (Fig. 1) as against 18 in the females. As in females the chromosomes of males are spherical or cubical in shape.



FIGS. 1-4. *Lacifer lac* (Kerr). Fig. 1. Spermatogonial metaphase (polar view). Fig. 2. Binucleate secondary spermatocyte with spermatids. Fig. 3. A spermatid. Fig. 4. Transfer of nuclear matter into sperm. NU, nuclear matter; SP, sperm; SPT, spermatid; SPT', sec. spermatocyte.

Rate of spermatogonial divisions is most vigorous at the pseudo-prepupal and early pseudo-pupal stages.

Among coccids the existence of XX female and XO male type of sex chromosome mechanism has been reported in members of the primitive family *Margarodidae* (Hughes Schrader, 1931, 1940, 1942 and Schrader, 1931). Among the Lecanoids this type of sex chromosome mechanism has been reported only in *Puto* sp. The present studies indicate the existence of a similar type in the lac insect also.

The author expresses his deep gratitude to Prof. K. C. Bose, for guidance and to Prof. A. C. Sen, Retd. Regional Director of Agriculture, Bihar, for his comments. Thanks are also due to the Indian Lac Cess Committee, Ranchi, for financing the scheme.

Department of Zoology, G. P. TULSYAN.  
Ranchi University,  
Ranchi, February 19, 1963.

1. Bose, K. C. and Tulsyan, G. P., *Proc. All-India Cong. Zool.*, 1962, **2**, 5.
2. Dikshit, S., *Curr. Sci.*, 1962, **31**, 383.
3. Hughes Schrader, S., *Z. Zellforsch.*, 1925, **2**, 261.
4. —, *Ibid.*, 1927, **6**, 509.
5. —, *Ibid.*, 1931, **13**, 742.
6. —, *Bio. Bull. Woods Hole*, 1940, **78**, 312.
7. —, *J. Morph.*, 1942, **70**, 261.
8. Schrader, P., *Z. wiss. Zool.*, 1931, **138**, 386.

## FREQUENCY OF TRIVALENTS IN AUTOTETRAPLOID GUAR

Irregular meiosis and other abnormalities are common in autopolyploids. In an attempt to induce polyploidy in *Cyamopsis psoralioides* D.C. the author observed a mixoploid plant resulting from aqueous colchicine treatment. In this case the PMC's revealed  $2n = 26$  and  $2n = 28$  from the same plant.

True autotetraploids ( $2n = 28$ ) were obtained in Ph. IV type of 'guar' by treating young seedlings with 0.2% colchicine-in-kanolin paste. Detailed studies of meiotic configurations revealed a large number of trivalents in one of the tetraploids. As a rule in an autotetraploid the frequency of trivalents should not exceed the frequency of univalents; but in the data under report the former occurred many times more than the expected frequency. The averaged records for all the cells studied were 3.25 IV, 3.75 III, 1.75 II, 0.25 I per cell.

The drawings of two PMC's from this plant are reproduced in Figs. 1 and 2. In each case



FIGS. 1-2. Fig. 1. An autotetraploid PMC showing 4 IV + 4 III. Fig. 2. An autotetraploid PMC showing 2 IV + 4 III + 4 II. Note the Ring Trivalent (→).

there are 4 III;—associated with 4 IV in the first cell and 2 IV and 4 II in the second cell. In certain instances the trivalents were seen in the form of a complete ring at Metaphase I plate (Fig. 2). A trivalent ring configuration in an autopolyploid is an impossibility unless the non-homologous partners pair at one point at least.<sup>2</sup> This is usually possible only in secondary trisomics.

The origin of such a high proportion of trivalents in an autotetraploid without the occurrence of univalents and the occurrence of secondary trisomic configurations suggest that the parent strain was heterozygous for some chromosome structural changes.

Agriculture College,  
Udaipur, February 11, 1963.

B. K. Vig.

1. Vig, B. K., *Sci. and Cult.*, 1962, 28 (9), 434.

2. Dawson, G. W. P., *An Introduction to the Cytogenetics of Polyploids*, Blackwell Scientific Publications, Oxford, 1962.

### INDUCED TETRAPLOIDY IN *ASCLEPIAS CURASSAVICA* L.

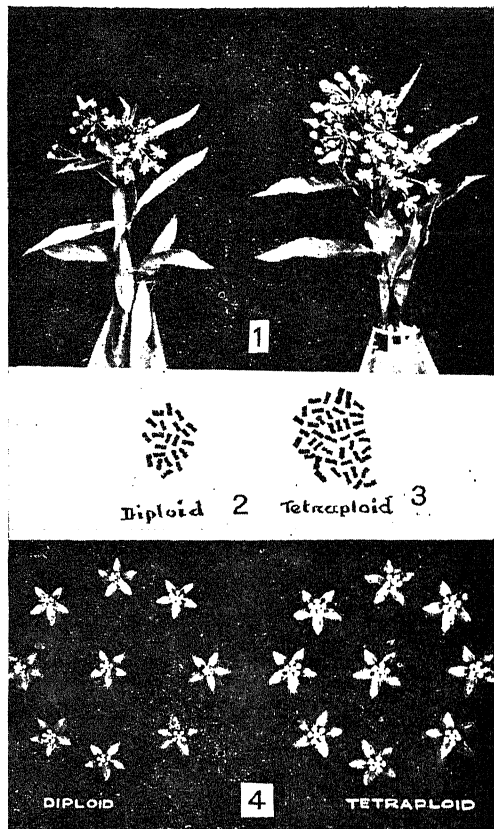
*Asclepias curassavica* L. commonly known as "Blood flower" is a native of tropical America and was introduced into India from the West Indies. It has now become naturalized in waste lands and roadsides chiefly on edges of water-logged places. It is also cultivated in gardens in many parts of India and other tropical countries for its beautiful flowers.

*A. curassavica* is a perennial herb, with opposite-decussate, narrow, lanceolate leaves. Flowers are small, in many bowered umbels, bright orange-red coloured with yellow corona, petals generally reflexed.

The plant is considered useful in phthisis and contains two glucosides asclepiadin and vincetoxin. The roots are used medicinally as an emetic and hence it is called Bastard or West Indian Ipecacuanha. The juice of the leaves is anthelmintic and is also used as sudorific (Chopra *et al.*, 1956).

Moore (1946) reported the chromosome number of *A. curassavica* as  $2n=22$ . Plants collected from Assam and examined by me had the same chromosome number. Tetraploid plants with chromosome number  $2n=44$  (Figs. 2, 3) were obtained by treating pre-soaked seeds with 0.1% aqueous solution of colchicine for 24 hours. They were larger and more robust than the diploids. The rate of shoot growth of the tetraploid plant was slower than the diploid plant. However, in

the long run they showed better growth and were more bushy. The leaves of the tetraploids were thicker and broader and had larger stomata. The flowers were also larger (Figs. 1, 3).



FIGS. 1-4. Fig. 1. *Asclepias curassavica*, diploid and tetraploid shoots. Fig. 2. *A. curassavica*, diploid  $2n=22$ ,  $\times 2,000$ . Fig. 3. *A. curassavica*, tetraploid  $2n=44$ ,  $\times 2,000$ . Fig. 4. Flowers of diploid and tetraploid *A. curassavica*.

My grateful thanks are due to Dr. E. K. Janaki Ammal for guidance and to Dr. I. C. Chopra for providing facilities.

Regional Research Lab., H. P. BEZBARUAH,\*  
Jorhat, Assam, February 12, 1963.

\* At present working at the Regional Research Laboratory, Jammu-Tawi.

1. Chopra, R. N., Nayar, S. L. and Chopra, I. C., *Glossary of Indian Medicinal Plants*, C.S.I.R., New Delhi, 1956.
2. Moore, R. J., *Canad. Jour. Res.*, 1946, 24 C (3).
3. Macmillan, H. F., *Tropical Planting and Gardening*, Macmillan & Co., London, 1956.

# FUSARIUM ROT OF GLADIOLUS

A dry rot of *Gladiolus* bulbs was observed during storage. Isolations from dried and mummified bulbs invariably yielded *Fusarium solani* (Mart.) App. and Wr. Though the organism has been reported on several hosts it was observed for the first time on *Gladiolus* in India.

Symptoms caused by *Fusarium solani* were similar to those of *F. oxysporum* var. *gladioli* described by Magie<sup>2</sup> (1953) (vide Fig. 1). Chromatographic analyses of carbohydrates in the healthy and diseased bulbs after one and a half month of infection revealed that maltose and sucrose present in healthy tissues were absent from diseased portions.

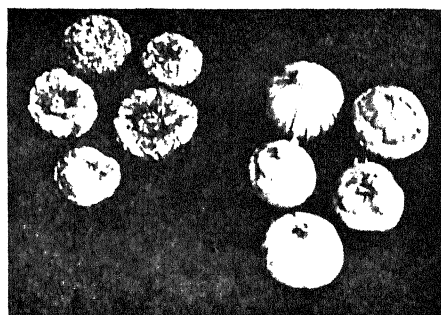


FIG. 1. Showing dry rot of *Gladiolus* bulbs caused by *F. solani* (left (diseased) and right (healthy).

Cultural studies were carried out on Asthana and Hawker's medium A.<sup>1</sup> It was observed that the fungus was capable of growing between pH 2.5 and 11.0 but the maximum growth and excellent sporulation were recorded between 5.0 and 5.5. The extract of normal bulbs and leaves showed that their pH was 5.5 and 5.2 respectively. Thus the range was suitable for growth of the fungus. Temperature studies showed that the organism was capable of growing between 10°C and 36°C. The optimum temperature was 25°C. There was no growth at 6°C but the organism was not killed as it could survive even after an exposure at this temperature for fifteen days. The thermal death-point was found to be 56°C. Studies on the longevity of fungus showed that the spores could survive in soil culture for more than 2 years while those produced on diseased bulbs were capable of initiating new growth up to a year only.

Pathogenicity was tested by different methods. High percentage of infection was observed when inoculations were made on injured bulbs. Rotting occurred on uninjured bulbs also but

the percentage infection was low (20% only). The maximum rot occurred between 25°C and 31°C and it was well established within 3 weeks. Slight rot appeared at 10°C within six weeks. There was no infection at 6°C but when such bulbs were transferred to room temperature they developed the rot. Further studies showed that the *Gladiolus* bulbs stored in soil infested with *F. solani* developed the rot. Cross-inoculations showed that it was capable of infecting potato tubers but had no effect on the bulbs of *Allium cepa* L. and *Narcissus*.

Fourteen different fungicides (Kirti copper, Flit-106, Cupramar, Micop W-50, Copper sandoz, Dithane Z-78, Blitox, Cupravit, Zerlate, Phygon, Cynside 75%, U.N.R. 50%, Isothane Q-15 and Bordeaux mixture 4:4:50) were evaluated in the laboratory and the minimum inhibiting concentrations of effective fungicides were determined. 0.5% Flit-106, used 3 weeks before infection, could check the dry rot of *Gladiolus* bulbs. Besides storage at low temperature, careful harvesting and handling of the bulbs are recommended for the control of the rot.

The junior author is grateful to the Council of Scientific and Industrial Research for awarding Junior Research Fellowship during the tenure of this work.

Department of Botany,  
University of Allahabad,  
Allahabad, March 3, 1963.

R. N. TANDON,  
S. N. BHARGAVA.

1. Asthana, R. P. and Hawker, I. E., *Ann. Bot.*, 1936, **50**, 325.
2. Magie, R. O., *Plant Diseases—The Year Book of Agriculture*, U.S.D.A., Washington, D.C., 1953, p. 601.

## SHOOT APEX IN *DOROTHEANTHUS BELLIDIFORMIS* N.E.BR.

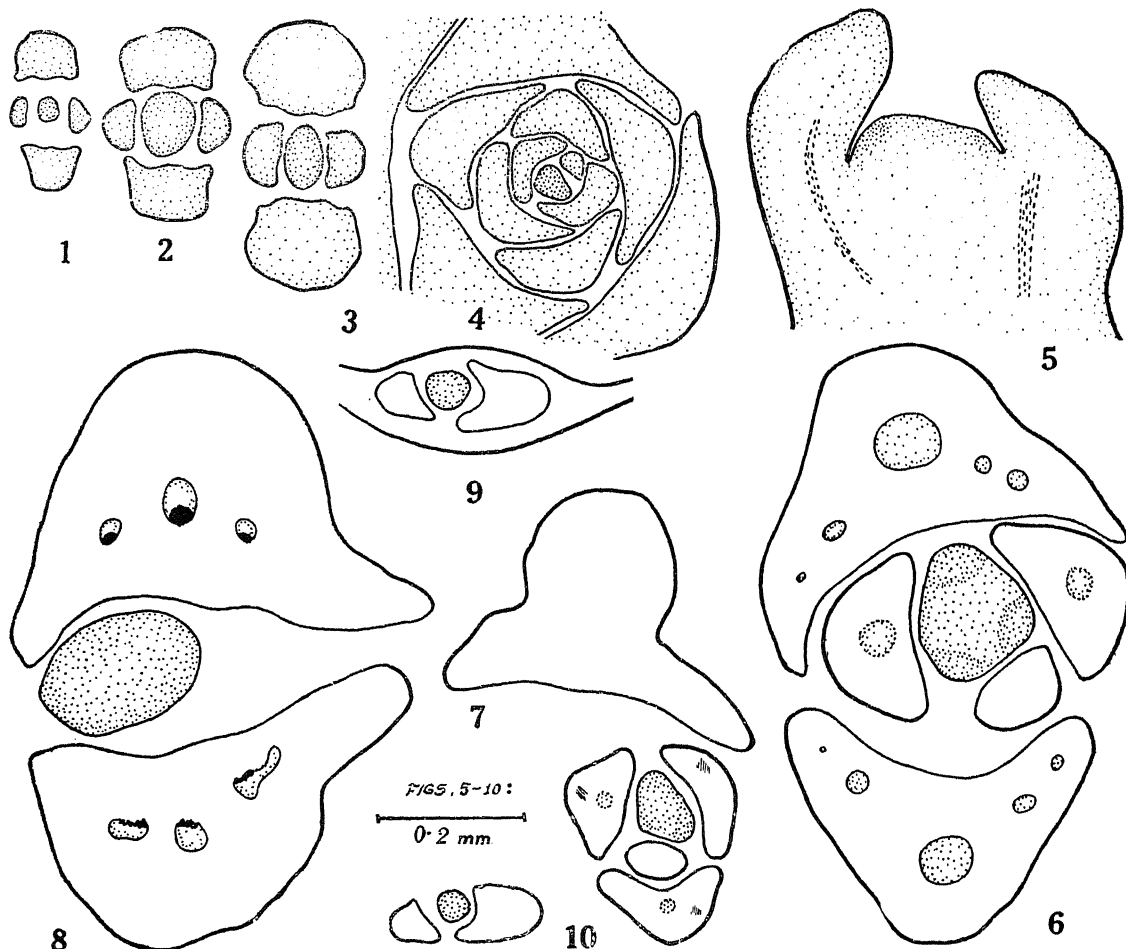
*Dorotheanthus bellidiformis* (*Mesembryanthemum bellidiformis* Burm.; *M. criniflorum* L.f.; *D. criniflorus* Schwant) is one of the species of the former genus *Mesembryanthemum* now split up into more than a hundred genera. While Engler and Prantl (1934) include it in the family Aizoaceae, Hutchinson (1959) places it in his Picoidaceae along with such other genera, as *Trianthema*, *Sesuvium*, *Tetragonia*, etc., which have a united perianth tube. Members of this species are low annuals with stipulate obovate leaves somewhat joined at the base. While some of the mesembryanthemums (*sensu lato*) have their leaves arising in an alternate or whorled manner, *Dorotheanthus bellidiformis*

bears them in an opposite and decussate manner (Bailey, 1961). The two leaves of a pair are often somewhat unequal. A similar condition is found in *Trianthema* also.

While studying the apical organization of the shoot in *Dorotheanthus bellidiformis* the author noticed a curious fact. As is generally known the shoot apex above the youngest pair of leaf primordia in plants, having decussate arrangement of leaves, presents an oval outline in transverse sections (Figs. 1-3). As against this the apices of those plants which bear leaves

in a spiral manner present a somewhat triangular outline in similar sections (Fig. 4).

As is apparent from transverse sections (Fig. 6) the shoot apex of *Dorotheanthus bellidiformis* is more or less triangular in outline just above the youngest leaf primordium. By comparison, it is very much similar to the apex of *Bougainvillea glabra* (Fig. 7), which has a spiral leaf arrangement, and dissimilar to that of *Mirabilis jalapa* (Fig. 8) which has an opposite and decussate leaf arrangement. These species, however, belong to a different



FIGS. 1-10. Figs. 1-3. *Cileus blumei* (leaves opposite and decussate) apices just above the insertion of the youngest pair of leaves and showing the change in shape of the apex during a plastochron (redrawn from Clowes, 1961). Fig. 4. *Saxifraga section Dactyloides*, showing shape of apex in plants having spiral leaf arrangement (redrawn from Clowes, 1961). Figs. 5-6. *Dorotheanthus bellidiformis*. Fig. 5. Median longitudinal section of the shoot at x. Fig. 6. showing shape of apex in transverse sections above the youngest leaf (Note the second leaf of the pair has not yet arisen though its primordium is distinguishable). Fig. 7. Showing shape of apex in *Bougainvillea glabra* (spiral leaf arrangement) in transverse sections. Fig. 8. Apex of *Mirabilis jalapa* (opposite and decussate leaf arrangement) in transverse sections. Figs. 9-10. Apex in *Trianthema pentandra* (opposite and decussate leaf arrangement) in transverse sections.



family (Nyctaginaceae), though an allied one. What is remarkable is that the shoot apex of the species under investigation differs even from that of *Trianthema pentandra* Linn. (Figs. 9, 10) which belongs to the same family, Euphorbiaceae, and also bears opposite leaves.

It appears, therefore, that the opposite and decussate arrangement of leaves in this species is not the original condition for the mesembryanthemums but a derived one from an originally spiral condition. This is further supported by the fact that the two members of a pair of leaf primordia in *Dorotheanthus bellidiformis* do not arise at the same level. This is clear both from transverse as well as median longitudinal sections (Figs. 5, 6). Besides, one of the two primordia lags behind in its development as well. It will be further noted that the two leaves of a pair do not arise exactly opposite to each other but are borne at a slight angle (Fig. 6).

I am grateful to Prof. K. N. Kaul for encouragement and to Dr. H. P. Sharma for guidance.

Plant Anatomy Laboratory, KARUNA MOHAN,  
National Botanic Gardens,  
Lucknow (India), February 13, 1963.

1. Bailey, L. H., *Manual of Cultivated Plants*, New York, 1961.
2. Clowes, F. A. L., *Apical Meristems*, Oxford, 1961.
3. Engler, A. and Prantl, K., *Die Natürlichen Pflanzenfamilien*, Leipzig, 1934, 16 C.
4. Hutchinson, L., *The Families of Flowering Plants*, Oxford, 1959, 1.

# **ARACHIS HYPOGAEA L. A HOST OF SOUTHERN SANNHEMP MOSAIC VIRUS**

SOUTHERN sannhemp mosaic virus (Capoor, 1950) is of widespread occurrence at Delhi. The virus has been reported to produce local necrotic lesions on guar, *Cyamopsis tetragonoloba* (L.) Taub. (Raychaudhuri *et al.*, 1962), which has been used for several quantitative studies. Capoor (1962) reported several hosts

of the virus. During the course of further studies, the virus was found to be readily transmitted to groundnut (*Arachis hypogaea* L.) by sap inoculation using carborundum powder as an abrasive. The first symptoms of infection appeared on the young leaves of *Arachis hypogaea* L. after about 6-8 weeks after inoculation in the form of faint chlorotic spots which gradually developed into distinct mosaic mottling (Fig. 1). The leaves were considerably reduced in size and the margins were slightly rolled upwards. Occasionally the base of the leaflets became narrow and fine granular blisters were produced on them. The virus could be recovered back on sannhemp. The leaves of guar when rubbed with the juice of infected groundnut leaves produced local necrotic lesions characteristic of the virus. Thus *Arachis hypogaea* L. happens to be a new host of the southern sannhemp mosaic virus not reported so far.



FIG. 1. Leaves of *Arachis hypogaea* affected with southern sannhemp mosaic virus.

The authors are grateful to Dr. B. L. Chona for his keen interest in the work.

Division of Mycology and  
Plant Pathology,  
Indian Agric. Res. Inst.,  
New Delhi-12, February 27, 1963.

Y. C. PALIWAL,  
T. K. NARIANI.

1. Capoor, S. P., *Curr. Sci.*, 1950, 19, 22.
2. —, *Phytopathology*, 1962, 52, 393.
3. Raychaudhuri, S. P., Nariani, T. K. and Das, C. R., *Indian Phytopathology*, 1962, 15, 79.

---



---

## REVIEWS

---



---

**Strange Particles and Strong Interactions.** By R. H. Dalitz. (Tata Institute of Fundamental Research, Bombay; Oxford University Press, Madras-2), 1962. Pp. 187. Price Rs. 19-00.

Professor Dalitz's earlier review article on the strong interactions of strange particles was noted for its clarity and its thorough treatment and has been always of great help to beginners as well as research workers in this field. The book under review which grew out of his lectures in the summer of 1961 at Bangalore, India, proves no exception. After a brief review of the various properties of the strongly interacting particles and of the underlying space-time symmetries of strong interactions, the full interplay between the concept of strangeness and these symmetries are brought out by an excellent discussion of the interesting behaviour of neutral K-mesons. Following this, the various resonant states that have been recently discovered and the possible assignment of the different quantum numbers of these states are treated.

Since at present our knowledge of the strong interactions as well as our ability to calculate the various properties involving strong interactions are limited, we can only hope to analyze the various strong interaction processes phenomenologically. To this end the reaction matrix formalism is developed in detail and is applied to the low energy K<sup>-</sup>p interactions in the next two chapters. A brief discussion of the properties of the pion-hyperon resonant states in KN reactions is given in the next chapter following which a short introduction to the N/D method is made. The present attempts in understanding the different reaction rates for the several channels possible in K<sup>-</sup>D absorption process as well as the effect of  $\Sigma$ - $\Lambda$  conversion in the final states are discussed in the next chapter. After this the various aspects of the cusps which occur in the scattering and reaction cross-sections at the threshold of new competing channels are analyzed in detail. In the following chapter all the methods available at present for an experimental determination of the parities of strange particles are summarized. The lecture notes end with a brief introduction to method of dispersion relations and a discussion of poleology and peripheral collisions.

Because of the excellent get-up and printing

of these notes, this monograph will be widely used. However the reviewer feels that the price of the notes is rather high especially for Indian students and perhaps we should take a cue from some of the Japanese publications whose prices are extremely reasonable.

N. R. RANGANATHAN.

**The Correspondence of Isaac Newton (III)—1688-94.** Edited by H. W. Turnbull. (Cambridge University Press, London, N.W. 1), 1961. Pp. xviii + 445. Price 7 guineas.

We had occasion to review the previous two volumes of this great undertaking, namely, *The Correspondence of Isaac Newton*, by the Royal Society of London. The present volume covers the period from December 1688 to August 1694, and contains letters numbered serially from 319 to 466.

About 20 letters in the beginning are those exchanged between Newton and John Covel, Vice-Chancellor of the Cambridge University. They throw some light on the political changes that had taken place in the country and how they influenced the University bodies. It was an unsettled period which followed the flight of King James II to France, and the landing of William, Prince of Orange, on English soil in November 5, 1688. In January 1689 Newton was elected to the Convention Parliament as one of the University representatives and the new responsibilities took much of Newton's time.

The publication of the *Principia* in 1687 led to some correspondence of interest between Newton and leading men of science of the time. In this volume there are four documents (letters 341-344) exchanged between Newton and Huygens of an explanatory nature relating to some essential propositions in the *Principia*.

Three earlier manuscripts of Newton (letters 347, 348 and 349), probably written during the years 1665-66 and 1672, are included in this volume, and they throw light on Newton's original thinking on the subject of motion and gravitation. A *facsimile* manuscript, reproduced as a plate, gives an idea of the enormous calculations which Newton was never tired of carrying out.

Newton's profound interest in theology and his deep biblical scholarship are revealed in his letters exchanged with Locke and Mill.

The letters (431-436) exchanged between Newton and Samuel Pepys (the Diarist) make interesting reading. They exhibit Newton's patience in explaining to an important personage of the time (by no means a student of mathematics), in an elementary manner the calculations connected with solving a problem of chance.

Some of the letters throw light on Newton's simplicity, greatness and humaneness.

The portrait of Newton by Jervas adorns the present volume as *frontispiece*.

We note with regret that Professor H. W. Turnbull who was responsible for editing these volumes died on May 4, 1961, before the present volume was published.

A. S. G.

**Structure Reports for 1953 (Vol. 17).** By W. B. Pearson. [International Union of Crystallography, N. V. A. Oosthoek's, Domstraat 11-13, Utrecht (The Netherlands)], 1963. Pp. viii + 863. Price \$ 35.00.

*Structure Reports* published by A. Oosthoek Publishing Company for the International Union of Crystallography and issued periodically, are indispensable volumes to crystallographers and other scientists whose chief interest is concerned with the structure of elements and compounds, with special reference to unit cell, space group, atomic positions and parameters, interatomic and intermolecular distances, etc.

Volume 17, of about nine hundred pages, concerns the papers published during the year 1953 and relevant for abstraction in the *Reports*. As readers familiar with the previous volumes know full well, these are not in the ordinary sense simple abstracts but they contain almost complete information so far as the important aspects of structure (mentioned above) are concerned.

The volume contains three sections: (1) Metals (pages 1-307) edited by the General Editor W. B. Pearson himself; (2) Inorganic Compounds (pages 309-603) edited by J. Wyart; and (3) Organic Compounds (pages 605-813) edited by J. M. Robertson. The Metals Section includes besides the elements, intermetallic compounds and alloys. The Organic Section includes besides the aliphatic and aromatic compounds, organo metallic compounds, natural products, alkaloids, proteins, DNA, etc.

Alphabetical subject index, and formula index given at the end will make references to substances in the text easy.

A. S. G.

**John von Neumann Collected Works (Vol. I).—***Logic, Theory of Sets and Quantum Mechanics.* Edited by A. H. Taub. (Pergamon Press, Headington Hill Hall, Oxford), 1961. Pp. x + 654. Price £ 5.

Dr. A. H. Taub, a close friend and admirer of John von Neumann, has done the scientific community a great service in having undertaken upon himself the arduous responsibility of assembling and editing the manuscripts and published papers of von Neumann in a proposed six-volume publication.

Shortly after von Neumann's death in 1957, a number of mathematicians devoted much time to studying the von Neumann files. One result of this study was the publication of a posthumous paper on "Non-isomorphism of certain continuous rings" in the *Ann. Math.* (1958). It also became apparent that these files contained a number of manuscripts, which though not complete in themselves are of such a nature as to form subjects of further researches and, if published, will evoke wide interest.

Volume I under review contains a collection of 27 published papers given in chronological order covering the years 1922 to 1929. They deal with subjects Logic, Theory of Sets and Quantum Mechanics. The volume starts with a thought-provoking article entitled "The Mathematician" first published in 1947 (*Works of the Mind*, edited by Robert B. Heywood, and published by University of Chicago Press), in which von Neumann discusses the nature of the intellectual effort in mathematics. This is the only article in English. All the other papers are in German as they appeared in the original.

At the end of the volume is given a Bibliography of John von Neumann's papers which will form the contents of the succeeding volumes to be issued in this series.

The collected works of John von Neumann should certainly prove to be an invaluable addition to all scientific libraries.

A. S. G.

**Microwave Circuit Theory and Analysis.** By Rabindra N. Ghose. (McGraw-Hill Book Company, New York), 1963. Pp. 418. Price \$ 12.00.

The object of this book is to attempt to bridge the gap between the physical and mathematical developments in the microwave field and present some basic principles of microwave theory and techniques. The book starts with a brief review of various analytical

techniques and mathematical tools such as Dirac's Delta function, Variational Principles, Integral equations, Green's function, etc., often useful for the analysis of microwave problems. In a book of this nature, as is expected, the mathematical techniques have been presented in a highly condensed form. As such certain prerequisites on the part of the reader have to be assumed.

The chapters on Dielectric waveguides, surface wave transmission lines, microwave filters, discontinuities in transmission lines, and non-reciprocal networks which are regarded as some of the modern advances in the microwave field will serve as introduction and help the student to get acquainted with the topics that are engaging the attention of the microwave engineers in recent years. It may be mentioned that a chapter on the propagation of microwaves through plasma could have been incorporated to make the book more up-to-date in the microwave field. The chapter on non-uniform transmission lines, in which field the author has made significant contribution, has been well presented.

A chapter on radiation and microwave antenna such as horn, slot radiators and surface wave radiators is conspicuously absent from the book. It is the view of the reviewer that the topic of radiation and antenna forms an integral part of microwave theory and as such this could have been included.

The book with all its chapters represent well most of the fundamental aspects of microwave theory. It is strongly recommended for teaching in the undergraduate as well as graduate classes. As the book is expensive, an Asian edition will bring the book within the easy reach of students in India.

S. K. CHATTERJEE.

**Synthesis of Feedback Systems.** By Isaac M. Horowitz. (Academic Press), 1963. Pp. xiv + 726. Price \$ 16.50.

This book could be classed as a text-book for graduate students in Electrical Engineering. It is written by an electrical engineer who has teaching experience and who has himself made useful contributions to the subject from both academic institutions and industrial organizations. The relationships between formalized analytical treatments and practical problems as they face the engineer are well brought out.

The subject-matter of the book is spread over a dozen chapters and an appendix. The systems discussed are single and multiloop, minimum

and non-minimum phase, absolutely and conditionally stable, open-loop stable and unstable, combined positive-negative feedback, sample-data, and multivariable. The printing and get-up of the book are very good. The diagrams are well drawn and well reproduced.

Basically, feedback is a means of coping with ignorance. Problems involving such ignorance can be classified under (a) nature of ignorance, (b) nature of objectives and (c) nature of constraints. The three axes of Ignorance, Objectives and Constraints suggest a three-dimensional region into which the problems of adaptive theory have to be fitted. For an extremely small volume in this region, there exists what may be considered as a quantitative feedback theory. A great deal of very useful work has been done on problems outside this small volume but the results cannot be considered to constitute a feedback theory. A proper realization of these basic limitations of our current methods of solving feedback problems in control systems engineering is very necessary in the instructional programmes of graduate students and this aspect of the problem gets highlighted in the book.

S. V. C.

**Comprehensive Chemistry.** By John Hicks. (Cleaver-Hume Press, London), 1963. Pp. xvi + 805. Price 35 sh.

This book written by the Headmaster of Gillingham Grammar School, Kent, is one of the best presentations of chemistry, the subject being developed very much along the classical approaches. It is surprising how each illustration conveys such a vast amount of information so lucidly.

The first 300 pages are devoted to physical chemistry, including periodic classification, valency, and oxidation and reduction. The next 250 pages deal with inorganic chemistry including radioactivity and nuclear chemistry; and the final 200 pages are devoted to organic chemistry. The 300 problems (selected from various question papers) given at the end of the book devolve on the basic principles of chemistry and give added understanding of the applications of the principles.

In the enunciation of Le Chatelier's principle (p. 146) 'constant' has to be altered to 'constraint'; and on the inapplicability of the Kjeldahl's method (p. 565) one might add 'or nitrogen' to 'compounds containing nitrogen atoms directly linked to oxygen'.

The book is strongly recommended to students and teachers of the Intermediate and even lower B.Sc. classes of the Indian Universities, where chemistry is still taught along classical lines.

G. B.

**Interpretation of Ultrastructure—**(*Symposia of the International Society for Cell Biology*, Vol. 1). Edited by R. J. C. Harris. (Academic Press, New York), 1961. Pp. x + 438. Price \$ 14.00.

The International Society for Cell Biology, which has so far published the proceedings of eight earlier symposia as supplements to *Experimental Cell Research*, has departed from this practice by bringing out the proceedings of the Symposium on the "Interpretation of Ultrastructure" held in Bern in September 1961 as a separate volume. The participants of the Symposium almost form the 'who is who' in the field of electron microscopy and ultrastructure of the cell. In this, considerable emphasis is laid on the importance of the developments of techniques for such study of ultrastructures. Among the subjects covered, particular attention is paid to the topics like the cell membranes and their structure and evolution, as is evident by the articles such as correlation of electron microscope and X-ray diffraction data in ultrastructure studies of lipoprotein membrane systems, light and electron microscopic study of membranous cytoplasmic organelles, the molecular structure of lipid-water systems and cell membrane models, the evolution of intracellular phospholipid membrane systems, etc. Other subjects, which have received equal attention, are the use of the instrument for the study of embryonic differentiation, the finer structure of the mitotic apparatus, ultrastructure of growing plant cell walls, the development of water-soluble embedding media for ultrastructural cytochemistry, etc. The use of negative staining techniques for the study of ultrastructures has also been discussed.

The volume is of value not only because the topics covered are of current interest, but also for the lucid presentation of the papers leading to focusing attention to the various problems of immediate interest. One of the assets of this volume is the excellent reproduction of the electron micrographs. It will be a most valuable addition to most libraries and can be recommended to specialists, as well as students of this subject.

S. K. MURTHY.  
J. GANGULY.

**On Growth and Form.** By D'Arcy Thompson. (*Abridged Edition.*) Edited by J. T. Bonner. (Cambridge University Press), 1961. Pp. xiv + 346. Price 32 sh. 6 d. net.

*On Growth and Form* was first published in 1917 and contained 793 pages. The last edition revised by the author was published in 1943 and ran to 1113 pages. Both have, during the period of years, become out-of-date consequent on the accumulation of newer knowledge and both suffered from the obvious disadvantage of being too long. It was clear that if this classic had to survive it had to be resurrected from both these disadvantages and the useful ideas set forth in it by D'Arcy Thompson be set against the background of newer knowledge accumulated during the past 40 years. That Prof. Bonner has done admirably and the result is a readable account contained within reasonable limits and bereft of the incongruities which were becoming more and more conspicuous as time went on.

It will be remembered that *On Growth and Form* was the first serious attempt to explain the facts and phenomena in biology in terms of physical and mathematical processes. In the second decade of the century the attempt was almost pioneer and the results were so striking that it appeared for the first time that there were no "vital" processes, and almost everything could be explained in terms of physics and mathematics. It is evident that the great popularity of the book was largely due to this novel approach. But there were serious omissions; chemistry, especially biochemistry, was completely ignored and the spectacular advances made in recent years in physiology, in genetics were not a little due to the methods and applications of chemistry. Many biological "facts" have undergone change, some of them quite considerably, and if the good that was in this book had to survive at all, it seemed imperative that it be separated out from that which was weak, effete and outmoded. Thus, the chapter on "Rate of growth" has been entirely omitted; recently our concepts of relative and differential growth have changed considerably and D'Arcy Thompson's views are not only old-fashioned but even erroneous. Another chapter that had to be cast away was that on the form and structure of the cell. Among the branches of biology which in recent years have made striking advances is the structure and function of the cell and while professional treatises on cytology have given way, it is no surprise that the rather amateur views of D'Arcy Thompson could not

survive long. A few others, his views on absorption, his note on geodesics and phyllo-taxis had also to go. Similarly, his dissertation "on shapes of eggs and certain other hollow structures" had to be sacrificed consequent on newer information having proved D'Arcy Thompson's views erroneous.

Actually, the whole thing is a sad story, but not entirely unknown in the field of Science, and with many parallels. A grand work, a classic of high stature, revealing great intellectual effort, fine and sympathetic understanding and appreciation of nature's phenomena and processes, and high literary merit,—to pull it down is sad, however inevitable. But the interests of truth must prevail and even a giant must step aside from its path.

B. R. SESHACHAR.

**The Asclepiadaceae and Periplocaceae of Bombay.** By the Rev. H. Santapau and N. A. Irani. (Botanical Memoirs No. 4 of the University of Bombay), 1960.

This memoir, part of which is based on a thesis by the junior author, deals with plants belonging to the two allied families Asclepiadaceae and Periplocaceae of the former Bombay State. In all, twenty-five genera of the former and three genera of the latter families have been described. In a brief introduction, the authors have pointed out the justification for splitting the original family Asclepiadaceae into the two separate, but closely allied families Asclepiadaceae and Periplocaceae, recognised as such owing to certain very distinctive characters which they respectively possess. They have also dealt with the classification and morphology of the two families and referred briefly to their economic importance. The authors have rightly remarked that, although it is easy enough to refer the plants to the family on account of the distinctive characters exhibited by the Asclepiadaceae, it is difficult for the average student to assign several of them to the genera and species. With this in mind, the authors have drawn up keys which are all artificial so as to help the student in identifying the plants from gross morphological characters. The usefulness of this work, especially in view of the participation in its preparation by the senior author who is an outstanding systematist in our country, can, therefore, be readily recognised, and the memoir should, therefore, find a place in all botanical libraries. The book is well got up and includes illustrations of some of the more typical plants

of the Asclepiadaceae. There is an appendix giving references to herbarium specimens under collectors' names and a general index at the end.

ESBEEKAY.

**Nitrogen in the Tropics with Particular Reference to Pastures—A Symposium.** (Bull. No. 45.) (Commonwealth Bureau of Pastures and Field Crops, Hurley, Berkshire, England), 1962. Price 35 sh.

This book has five sections dealing respectively with General problems of nitrogen economy, Soil nitrogen, Plant nitrogen, Nitrogen fixation, and Some aspects of nitrogen and plant production. The subjects discussed refer to a Symposium held in Brisbane, Australia, the objective of the Symposium being to review existing information on the role of nitrogen, a universal and important requirement in the tropical and sub-tropical agriculture, with emphasis on aspects relevant to Australia. A perusal of the book however shows that the topics included could be of wider importance and of value to research workers outside Australia.

Section I provides information on nitrogen-fixing plants of Leguminaceae as well as members of a few other families which have nodules of which *Casuarinaceae* in which two species fix nitrogen. Critical information on non-symbiotic nitrogen fixation by bacteria, fungi and algae is also provided. The other sources of nitrogen added to soil by atmospheric precipitation, and additions in the shape of manures, fertilizers, seeds, etc., are also referred to. There is also reference to non-biological fixation of nitrogen, chiefly contributions by Prof. Dhar and his co-workers from Allahabad, India, and the review states that doubts of their validity can only be resolved by careful repetition of the experiments using isotope  $N^{15}$  and modern bacteriological techniques. The section next deals with the various source of losses of nitrogen from the soil through leaching, crop removal, erosion and unaccountable losses, and the limitations of estimating such losses with lysimeter and laboratory methods, and finally on the nitrogen intake and excretion of grazing animals.

In Section II available information on the Physiology and biochemistry of nitrification and de-nitrification in the soil and the conditions that regulate and control the processes is summarized. Reference is also made to nitrogen transformations in the soil excluding de-nitrification and factors which influence the mineral-

ization and immobilization of nitrogen in the soil.

Section III on plant nitrogen may be considered important and of general interest to all plant physiologists. The review traces the pathway of nitrogen from its assimilation in the inorganic form by the plant through its conversion to simple organic compounds to the synthesis of cellular protein. The current theories of protein synthesis in plants together with critical evidence on which they are based are explained, including reference to the effect of nutrient deficiencies of several minor elements on nitrogen metabolism, although the source of information for the latter is mostly from observations on micro-organisms.

Unlike Section I, Section IV deals with the biology of nitrogen fixation, and factors which affect directly and indirectly fixation of nitrogen by legumes. Section V refers to some aspects of nitrogen and plant production and the use of fertilizers on pastures in the tropics and subtropics, and closes with information on the nitrogen requirements of grain and forage crops with special reference to Queensland, Australia.

As is usual with Commonwealth Bureau publications the present volume contains so much of critical information on a vast and important subject condensed in 180 pages which should make a good reference volume to research workers.

K. R.

#### Books Received

*Fundamentals of Ultrasonics.* By J. Blitz. (Butterworth & Co., 88, Kingsway, London W.C. 2), 1963. Pp. ix + 214. Price 35 sh.

*A Fortran Primer.* By E. I. Organick. (Addison-Wesley Publishing Co., Reading, Mass., U.S.A.), 1963. Pp. 186. Price \$ 3.95.

*Proceedings of the Eastern Theoretical Physics Conference.* Edited by M. E. Rose. (Gordon and Breach, Science Publishers, 150, Fifth Avenue, New York-11, N.Y.), 1963. Pp. viii + 462. Price \$ 5.00.

*Proceedings of IGG Symposium* (Vol. I). (Council of Scientific and Industrial Research, New Delhi), 1962. Pp. x + 246. Price Rs. 18.

*Physiological Pharmacology—A Comprehensive Treatise* (Vol. I). *The Nervous System* (Part A). Edited by W. S. Root and F. G. Hofmann. (Academic Press, New York), 1963. Pp. xvi + 703. Price \$ 22.50.

*Compact Calculus.* By P. Franklin. (McGraw-Hill Book Co., New York), 1963. Pp. 245. Price not given.

*Electrons in Atoms.* By G. F. Lothian. (Butterworths & Co., Pub. Ltd., 88, Kingsway, London W.C. 2), 1963. Pp. ix + 196. Price 35 sh.

*The Thirteenth Symposium of the Society for General Microbiology—Symbiotic Associations.* Edited by P. S. Nutman and B. Mosse. (Cambridge University Press, London. N.W. 1; India: Macmillan and Co., Madras-2), 1963. Pp. x + 356. Price 50 sh.

*Advances in Botanical Research* (Vol. I). Edited by R. D. Preston. (Academic Press, London W. 1), 1963. Pp. xii + 384. Price 70 sh.

*Rothamsted Experimental Station Report for 1962.* (Rothamsted Experimental Station, Harpenden, Herts), 1963. Pp. 316. Price 15 sh.

*Hydrodynamic Superposability.* By Ramballabh. (Asia Publishing House, Bombay-1), 1963. Pp. 45. Price not given.

*Advances in Physical Organic Chemistry* (Vol. I). Edited by V. Gold. (Academic Press, Inc., Berkeley Square, London W. 1), 1963. Pp. xv + 443. Price 90 sh.

*The Ecology of Fishes.* By G. V. Nikosky. (Academic Press, Inc., Berkeley Square, London W. 1), 1963. Pp. xv + 352. Price 75 sh.

*Advances in Insect Physiology* (Vol. I). By J. W. L. Beament, J. E. Treherne and V. B. Wigglesworth. (Academic Press, Inc., Berkeley Square, London W. 1), Pp. xiii + 512. Price 105 sh.

*Electroluminescence and Related Effects.* By Henry F. Ivey. (Academic Press, Inc., 111, Fifth Avenue, New York), 1963. Pp. xii + 276. Price 11 Dollars.

## SCIENCE NOTES AND NEWS

### Award of Research Degrees

Andhra University has awarded the D.Sc. Degree in Physics to Shri B. V. Krishnamurthy for his thesis entitled "Studies on Equatorial Spread F" and to Shri C. Abhirama Reddy for his thesis entitled "Studies on Polarisation of High Frequency Radio Waves"; D.Sc. Degree in Chemistry to Shri D. Purushottam for his thesis entitled "Studies on Lanthanons and Actinons (Complex formation with B. Diketenes)"; D.Sc. Degree in Geophysics to Shri B. Madhava Reddy for his thesis entitled "Studies on the Ionospheric Absorption at Waltair"; and the Ph.D. Degree in Physics to Shrimati A. Bhanumathi for her thesis entitled "Experimental Studies on (a) Eyring's Equation of Relaxation Time and (b) Hydrogen Bond Formation from Dielectric Measurements".

Gujarat University has awarded the Ph.D. Degree in Physics to Shri V. K. Thankappan of Physical Research Laboratory, Ahmedabad, for his thesis entitled "Collective Vibrations in Light Nuclei"; and to Shri S. K. Shah of Physical Research Laboratory, Ahmedabad, for his thesis entitled "Studies in Structure and Properties of Light Nuclei".

### Tenth International Botanical Congress—Edinburgh, 1964

The Tenth International Botanical Congress is to be held in Edinburgh, Scotland, from 3rd to 12th August 1964. The 2nd Congress Circular, which gives details of the scientific programme and the full programme of botanical excursions, is due to be despatched in August or early September. The Congress Executive wish to inform the readers of this Journal who do not receive the circular that they may receive it by writing to the "Secretary (Executive Committee), X International Botanical Congress, 5, Hope Park Square, Edinburgh-8, Scotland". The Executive would also be pleased if they would bring this notice to the attention of any of their colleagues who they think might wish to attend the Congress.

### Fluorspar in Kerala State

Dr. M. S. Krishnan, National Geophysical Research Institute, Hyderabad, writes:

Mr. P. A. Varughese of the Natural Science Department of UNESCO Office, Paris, who is on short leave in Kerala State, reports the find of

Fluorspar deposits at 4 or 5 places along the Tiruvalla-Mallapalli Road in the Aleppey District, Kerala State. The localities are in Survey of India Topo-sheet No. 58 C/11 and have been exposed by recent quarrying for road metal. The country rocks which are ancient gneisses are traversed by Pegmatite Dykes. The mineral occurs as massive veins, varying in thickness from stringers to bands up to 24" across. They are seen to extend for 3 ft. or more horizontally. The material is white and purple in colour and closely associated with quartz and feldspar. Chemical tests are reported to have confirmed the mineral as Fluorspar. Further work is in progress which will be followed by a detailed note by Mr. Varughese.

### A Diploid Parthenium in Jammu

With reference to the note under the above title published in *Curr. Sci.*, 1963, 32 (6), p. 273, Shri R. S. Rao, Regional Botanist, Botanical Survey of India, Western Circle, Poona-1, writes:

*Parthenium hysterophorus* Linn. has already been reported by the writer in 1956 as a newly introduced weed in India (*vide Jour. Bomb. Nat. Hist. Soc.*, December 1956). From the data gathered by him it appears that this American weed made its first appearance at Poona along the Agricultural College farm area only, sometime in 1954-55, possibly through the seed material of some crop plants imported from America. This has now become, during these 9 years, the worst weed in gardens and waste places in Poona and surroundings and the writer has recently observed a few plants in the N.C.C. Academy Colony on the Purandhar hill, 30 miles from Poona, evidently transferred by human agency from Poona. During the study of the flora of Western India, the author has not so far observed this species growing in other parts of Western India.

### New System for Satellite Designation

A new system for designating satellites and space probes has been adopted by the Committee on Space Research (COSPAR) at its meeting in Washington in May 1962. In the United States this system has been adopted by the National Aeronautics and Space Administration (NASA).



According to the new system, beginning from January 1, 1963, Arabic numerals will replace the Greek letters. Thus the first satellite or space probe in 1963 will be 1963-1, the second will be 1963-2, etc. The numbering will also begin anew each year.

Prior to 1963, satellites were named in the order of the letters of the Greek alphabet, beginning anew each year.

Usually the launching of a satellite places more than one object in space. The new system provides that the suffix A will identify the main satellite (the one carrying the principal scientific payload), and that B, C, etc., as needed will be used for any subsidiary scientific payloads in separate orbits, and then for inert components.

### An "Active" Magmatic Ore Solution

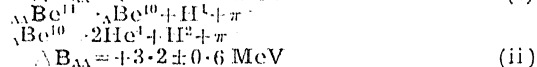
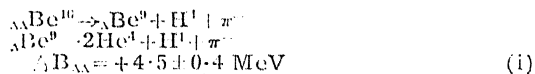
A well drilled for geothermal power to a depth of 5,232 ft. in the Salton Sea region of California has resulted in geochemical discoveries of quite unusual interest. This is the world's deepest well in a high-temperature hot-spring province, with depth temperatures in the range 270-370°C. It taps a very saline brine of Na-Ca-K-Cl type (185,000 p.p.m. chlorine), with exceptionally high content of potassium (23,300 p.p.m.) and with perhaps the highest content of minor alkali elements known for natural waters; and it is believed that this brine may derive from the same magma chamber as furnished the late Quaternary rhyolite domes of the region, representing an undiluted magmatic water residual after the separation of a more volatile phase represented by near-surface hot-spring manifestations. During a three-month production test several tons of material precipitated in the discharge pipe, this deposit consisting dominantly of amorphous silica with iron and manganese, and abundant bornite. Chemical analyses reveal the astonishingly high content of about 1.5% copper, 2% silver and notable arsenic, barium, lead, antimony, and some minor elements. The brine may therefore be the first example of an "active" magmatic ore solution. Drill cores from 4,400 to 5,000 ft. depth contain chlorite, albite, epidote, mica and quartz, with some indication of increase of metamorphic grade downwards, suggesting that the young sedimentary rocks are undergoing contemporary metamorphism. Dr. D. E. White, of U.S. Geological Survey, is conducting geochemical investigations of the brine and drill cores. (*Science*, 1963, 139, 919; *Nature*, 1963, 198, 1146.)

### Observation of a Double Hyper-Fragment

During a systematic scan for interactions of 1.3 and 1.5 GeV/c K-mesons in emulsions irradiated in the separated K-meson beam at CERN, an event has been found which is interpreted as the production and subsequent mesonic cascade decay of a double hyper-fragment.

Analyses of the observed tracks have shown that the double hyperfragment decayed into a  $\pi$ -meson, a singly charged particle, and an ordinary hyperfragment. This hyperfragment again decayed into a  $\pi$ -meson and three other charged particles.

After considering various possibilities, it has been suggested that the most likely explanation of the whole sequence of events is the production of a double hyperfragment,  $_{\Lambda\Lambda}Be^{10-11}$  by a Xi-minus ( $\Xi^-$ ) hyperon capture on carbon followed by the decay sequences:



—(*Phys. Rev. Letters*, July 1 1963, p. 29.)

### Differential Thermal Analysis of Opal

Investigations of the differential thermal analysis of opals have indicated that they show marked thermal absorption or "endotherm" with peak at about 130°C. According to J. B. Jones *et al.*, who have recently studied the differential thermal analysis of some thirty naturally occurring opaline silicas, the opals can be broadly classified into the following three groups: (1) those which show a *very small* or no apparent endotherm between 100° and 200°C, (2) those which show a *prominent but rounded* endotherm starting at 90°C. and with peak temperature in the range 125°-140°C. and (3) those which show a *strong and sharp* endotherm starting at 90° with a peak temperature of 140°C.

Most glassy opals (including precious varieties) fall into the group (1); opals which are commonly opaque come in group (2). Only two samples have been found in group (3) and these were somewhat glassy red and brown opals from different localities. They gave identical differential thermal analysis traces.

It was also observed that opals of group (1) were losing water even at 500°C., while those of group (3) were almost dehydrated at 200°C. These results indicate that most of the water is not chemically bound in opal.—(*Nature*, 1963, 198, 1191.)

### New Uses for Depleted Uranium

Ordinary uranium that has been stripped of its fissionable isotope U-235 is named depleted uranium and it is a by-product of the nuclear industry. New uses are being developed for depleted uranium for applications in aerospace and other advanced technologies. Highly dense, easily machined and strong when alloyed with other metals, depleted uranium is an excellent material for balances and counterweights for aircraft and space vehicles. Because of its density, it also makes good radiation shielding. Uranium is nearly twice as dense as lead. Its only equal is tungsten, but tungsten costs more than uranium in raw form, and its brittleness makes it far more expensive to fabricate. The depleted uranium is cast, melted and machined as easily as any conventional metal. Finished products of depleted uranium offer no health or radiation problems.

### Satellite Gyroscope Experiment to Test Theory of Relativity

A new experiment is being designed by scientists of the Stanford University to test Einstein's General Theory of Relativity. The experiment involves use of a frictionless, free-fall gyroscope suspended in space within a vacuum inside a satellite. The gyroscope would have neither bearings nor air to slow it down, and thus no friction. Once in rotation it would continue to spin almost indefinitely. The weightlessness of gyroscope in a "Zero-g" (Zero-gravity) satellite makes the experiment appear feasible.

The experiment requires observation of this extremely high precision gyroscope while it is in orbit in the satellite. Precise measurements would then be made of the "precession" of the gyro rotor's spin axis. This precession would be caused by the Earth's gravitational field, and is predictable according to Einstein's General Theory. In the gyroscope the axis movement should be seven seconds of arc per year. This is speeded up 15 or 16 times over the normal rate of precession because the satellite will orbit the earth that many times a day.

The apparatus would include an astronomical telescope to keep the satellite aimed at a fixed star. A long-lasting vacuum for spinning rotor

would present no great problems and the zero-g environment of space would greatly simplify the task of keeping the rotor suspended. While there are several possible means of supporting the rotor, the most promising method would be not to support it at all. The satellite would use jets to "servo" its own path through space to match the path of the rotor inside.—(*Jour. Frank. Inst.*, 1963, 275, 456.)

### Drifting Continent

Fossil-magnetization and radioactive dating studies of rocks from eastern Australia and Tasmania have added new evidence that Australia was once much nearer the South Pole than it is today, and has arrived at its present location only within the past 100 million years. In that short geological span the southern continent may have drifted as much as 3,000 miles with respect to North America and Europe at a rate approaching two inches a year.

In these studies several hundred specimens from more than a score of sites in four areas of eastern Australia and one site in Tasmania were investigated. The samples included sedimentary, igneous and volcanic rocks ranging in age from 93 million years to well over 200 million years. All were tested for *remanent magnetization*, and where possible, samples from each area were also dated by the potassium-argon method.

The specimens from all five areas point to a location for the South Pole much closer to Australia then than now. This location, however, differs by nearly 50° from positions for the Pole derived from similar studies of North American and European rocks of comparable age.

The conclusion is either that the earth's magnetic field then had some unusual configuration (with more than the present two poles) or that Australia has since moved. It is to be noted that other paleomagnetic studies, involving younger rocks, suggest that Australia began to move about 100 million years ago, not long after the postulated date for the breakup of the supercontinent of which advocates of continental drift believe Australia was once a part.—(*Sci. Amer.*, June 1963.)

557-63. Printed at The Bangalore Press, Bangalore City, by T. K. Balakrishnan, Superintendent, and Published by S. R. S. Sastry, for the Current Science Association, Bangalore.

All material intended for publication and books for review should be addressed to the Editor, *Current Science*, Raman Research Institute, Bangalore-6.

Business correspondence, remittances, subscriptions, advertisements, exchange journals, etc., should be addressed to the Manager, Current Science Association, Bangalore-6.

Subscription Rates : India : Rs. 12-00. Foreign : Rs. 16-00; £ 1-4-0; \$ 4.00.

## THE VISUAL PIGMENTS AND THEIR LOCATION IN THE RETINA

SIR C. V. RAMAN

THE faculty of perceiving light and colour which is one of our most precious possessions and plays an immensely important role in our lives is made possible by the marvellously organised structure of the retina and its connections with the cerebral centres. It is not surprising, therefore, that the details of that structure have been the subject of innumerable researches in the past. It is appropriate that we commence the present communication by briefly recalling those features of the retinal structure which have a bearing on the subject which will be dealt with here.

The retina may be described as an outlying part of the central nervous system to which it is connected by a tract of nerve fibres, namely the optic nerve. The nervous structure is encased within two coats which serve the purposes of protection and nutrition. Externally, we have the fibrous tunic which is white and opaque, namely, the sclera. Between this and the retina is a layer of which the function is primarily nutritive. This is known as the choroid and is a tissue almost entirely composed of blood vessels. Behind this again lies the retina which functions as the organ for the reception of visual impressions.

The retina itself is a multi-layered structure. The two innermost layers adjoining the choroid coat are respectively the pigment epithelium and the layer of rods and cones. These latter are recognized as the visual receptors. The two outermost layers of the retina are the so-called inner limiting membrane and the layer containing the optic nerve fibres. Between these two sets of layers appears an elaborate organisation of connective cells, pictures of which will be found in the anatomical treatises.

The area of the retina can be usefully divided into two parts, a central region

measuring five to six millimeters in diameter and the peripheral part which is a much larger area surrounding it. An important part of the central retina is the area known as the *fovea*. This is a shallow rounded pit of which the diameter is about 1.5 millimeters. At the bottom of this pit is the area known as the *foveola* which is about 0.3 millimeters across. The depression of the fovea below the general level is due to the practical disappearance of the inner layers of the retina, compensated somewhat by the increased thickness of the layers containing the rods and cones. Outside the fovea and in the central retina, two further regions have been recognized and distinguished from each other on morphological grounds, namely the *parafovea* which is a belt 0.5 millimeters wide all round the fovea, and a second belt known as the *perifovea* which is about 1.5 millimeters across.

It is well known that the *fovea* plays a highly significant role in human vision. It is the region of the retina on which the image of any object falls towards which we direct our vision. When the fundus of the living eye is viewed through an ophthalmoscope, the fovea can be glimpsed at the centre of the region of the retina known as the macular area. The fovea is seen somewhat more conspicuously with the ophthalmoscope when the fundus is viewed in red-free light, it being then visible as a spot of yellowish hue surrounded by a greenish-yellow field. This effect arises from the presence of a yellow pigment in the macular area which permeates diffusely the retinal tissues from the outer nuclear layers inwards.

The present communication is concerned with the visual perception of colour and the part played by the retina in such perception. It is useful here to recall the basic facts of the subject. The visible spectrum is comprised in the wavelength range between

400  $m\mu$  and 700  $m\mu$ , the perceived colour altering continuously from one end of the range to the other. It may be demarcated into six regions, designated as violet, blue, green, yellow, orange and red respectively; the limits between them are indicated in Fig. 1 by broken vertical lines whose positions have been taken as 436  $m\mu$ , 495  $m\mu$ ,

The most rapid increase of the luminous efficiency as we move towards greater wave-lengths appears at about 520  $m\mu$  and the most rapid fall at about 590  $m\mu$ .

Figure 2 shows the hue discrimination curve, in other words, the smallest change in wavelength which manifests itself in vision as a perceptible change of colour in

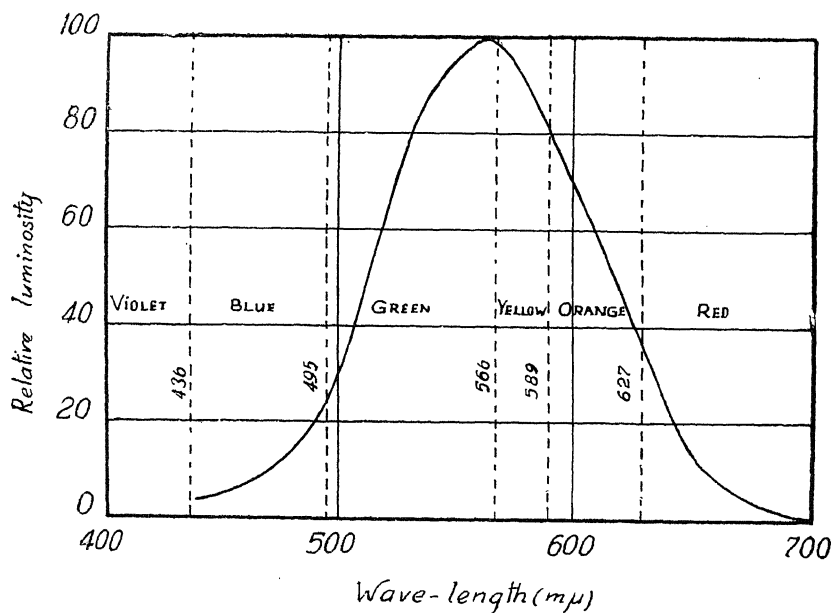


FIG. 1. Luminous Efficiency of the Visible Spectrum.

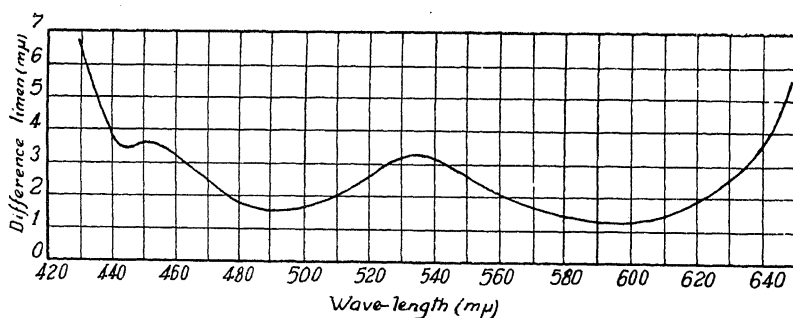


FIG. 2. Hue Discrimination in the Spectrum.

566  $m\mu$  and 627  $m\mu$  respectively. The luminous efficiency of visible radiation reaches very low values at either extremity of the range. Intermediately, as shown in Fig. 1, it reaches a maximum at 560  $m\mu$ , in other words not far from the boundary between the green and yellow sectors of the spectrum.

various regions of the spectrum. It will be noticed that except near the ends of the spectrum, a change of 4  $m\mu$  is more than sufficient to produce an observable change of hue. Indeed, over the greater part of the spectrum, the power of colour discrimination is much greater. Dips in the curve appear at 444  $m\mu$ ,

492 m $\mu$  and 595 m $\mu$ , these wavelengths being nearly the same as those at which the observed colour changes from violet to blue, from blue to green and from yellow to orange respectively.

The present communication records the results obtained and the conclusions reached from a study of the functioning of the retina in its central region in terms of colour sensitivity. The method of investigation is that devised by the author and described in earlier publications by him, but it has now been much improved by reason of the attention paid to important details of the technique. The method of observation makes use of a set of colour filters so chosen or prepared that they are more or less completely opaque to a limited region of the visible spectrum but transmit other parts of the spectrum freely without any sensible absorption. Holding such a filter in front of his eye, the observer views a brightly illuminated white screen, fixing his vision at some particular point on the screen and after a short interval of time, varying from a few seconds to a few minutes according to the circumstances of the case, suddenly removes the filter from before his eye. He then observes on the screen an enlarged picture of his own retina, the nature of which varies with the filter used. From the nature of the picture seen, the spectral sensitivity of the retina and its variations over its central region, and especially the dependence of such sensitivity on the choice of the spectral region may be inferred.

How the effects observed in this manner with the aid of the colour filters arise is an important question regarding which some remarks of a preliminary nature may be made here. It is evident that if the colour filter cuts off a limited part of the spectrum, in the light which reaches the observer's eye through the filter that part of the spectrum would be missing, and hence it would also be missing in the light falling on the retina. The interval of time during which the

observer views the screen through the filter is much too short for any retinal fatigue to be produced by the parts of the spectrum transmitted by the filter. *But it may suffice to enhance the sensitivity of the retina to the parts of the spectrum cut off by the filter.* The extent of such enhancement may be expected to depend on the circumstances of the case, viz., the part of the spectrum screened off by the filter, the state of adaptation of the retina to light before the filter is put in, the illumination of the screen which is viewed and finally the duration of time for which the filter is held in front of the eye before it is removed.

In the earlier studies by the author, the colour filters employed were gelatine films on glass stained to the desired extent. While there is much to be said in favour of such filters, it has been found desirable in critical studies to use instead, aqueous solutions of various dye-stuffs contained in glass cells, 10 centimeters by 10 centimeters in area and 2.5 centimeters in depth, which is then the effective absorption path. The advantage of using such cells is that the filter may be quickly prepared by dissolving a little of the dye-stuff in distilled water, and then by diluting the solution to the desired extent. The spectrum of the light transmitted by such a filter may be observed at different dilutions and the state of dilution may be adjusted suitably. This procedure is very helpful, since strong solutions of the dye-stuffs used absorb extensive regions of the spectrum, but when sufficiently dilute the region of cut-off is greatly restricted and may indeed then be confined to the specific absorption bands characteristic of the dyestuff.

Amongst the dye-stuffs which had been employed in the present investigation may be mentioned the following, the names being those under which they are commercially available: (1) Acridine orange, (2) Eosine, (3) Rhodamine, (4) Coomassie brilliant blue, (5) Methyl violet and (6) Lissamine green.

Of particular importance are the observations made with solutions of these dye-stuffs of such dilution that the absorption is strong or nearly total in a limited region of the spectrum, while the rest of the spectrum is freely transmitted. Using this technique, the entire spectrum may be surveyed in detail. It emerges that it divides itself according to the observed results into five distinct regions: (1) 400–495  $m\mu$ , (2) 495–540  $m\mu$ , (3) 540–560  $m\mu$ , (4) 560–590  $m\mu$ , and (5) 590–700  $m\mu$ . Absorption only in the first of these regions may be obtained with appropriately diluted solutions of acridine orange. Absorption appearing only in the second region may be obtained with very dilute solutions of eosine; an absorption appearing only in the third and fourth regions with dilute solutions of coomassie brilliant blue,

screen. In the second region, namely 495–540  $m\mu$  no effect of any kind is noticeable, since on the removal of the filter, the observer sees the white screen as before. In the fifth region, namely 590–700  $m\mu$ , following the removal of the filter the observer sees a rose-red glow covering the entire screen. Using filters whose absorption is effective in the third and fourth regions, in other words between 540  $m\mu$  and 560  $m\mu$  and between 560  $m\mu$  and 590  $m\mu$ , very striking effects which reveal the structure of the retina are observed. The actual picture of the retina seen by the observer with such filters exhibits colours depending on the part of the spectrum which is cut off or weakened by the filter. But its general configuration is sufficiently well illustrated by the drawing in black and white reproduced as Fig. 3.

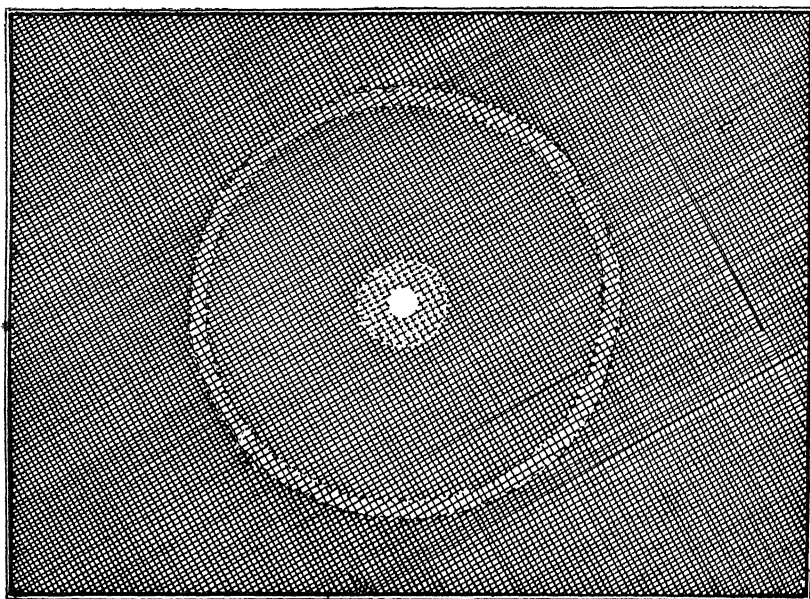


FIG. 3. The Retinal Picture seen with Colour Filters.

or methyl violet and in the fifth region alone with very dilute solutions of lissamine green.

The experimental results may be briefly summarised as follows. Working in the first region which comprises the blue-violet parts of the spectrum, the observer notices on the screen following the removal of the filter, a blue glow covering the entire area of the

Four distinct areas appear in Fig. 3, whose correspondence with the different parts of the central retina may be checked by actual measurement of the angular dimensions of these features as seen on the observing screen. Around the point on the screen at which the observer's vision is fixed appears the foveal disk (enormously magnified)

with the central pit or foveola and the umbo or navel very distinctly noticeable therein. Surrounding the fovea is seen a third region which appears encircled by a distinct halo along its margin. Outside this appears a fourth region without any distinct outer limits defining its extension. In general, by far the most luminous part of the picture is the fovea and this also exhibits vivid colour. The parafoveal and perifoveal regions are less luminous and distinctly less colourful.

Observations made with solutions of coomassie blue, methyl violet and lissamine green in different states of dilution make it evident that the retinal picture seen with the filter technique is different in the two cases where the absorption by the filter appears respectively in the third and fourth spectral ranges, *viz.*, 540–560  $m\mu$  and 560–590  $m\mu$ . In the third range, the fovea appears as a disc of a green hue and the perifovea also appears of the same colour. When the absorption is in the fourth range, the fovea is seen as of a bright yellow colour and the perifovea is likewise of that hue though less brilliant.

We may now proceed to consider what the observations described above signify in relation to the role played by the retina in the perception of colour. The effects observed are of a transitory nature in every case, but they differ enormously in the different parts of the spectrum. These differences are evidently connected with the variations in the luminous efficiency of radiation in the different parts of the spectrum. In the blue-violet and in the red regions of the spectrum, the effect observed following the removal of the filter is a glow covering the entire screen. It is noteworthy that for such an effect to be observed, it is necessary to hold the filter for an appreciably longer period in front of the eye. It may therefore be reasonably explained as due to the sensitisation of the retina for the wavelengths absorbed by the filter by its screening effect. On the other hand, the luminous efficiency of

the spectrum is fairly high in the region between 495  $m\mu$  and 540  $m\mu$  and it is not surprising, therefore, that no effect at all is observed when the filter which has an absorption in this region is put in front of the eye and then removed.

We may now proceed to consider the explanation of the effects pictured in Fig. 3. They appear only when the colour filters used have absorptions in the wavelength range lying between 540  $m\mu$  and 590  $m\mu$ . This spectral range is precisely that where the luminous efficiency of the spectrum is highest. It follows that the origin of these effects is quite different from those of the effects observed in the blue-violet and red regions of the spectrum which have very low luminous efficiencies. That the character of the effects is very different is also not surprising.

A reasonable explanation for the effects pictured in Fig. 3 appears to be that the visual pigment functioning in the spectral region between 540  $m\mu$  and 590  $m\mu$  is not identical with those functioning in the blue-violet, green or red sectors of the spectrum and that it is distributed in a highly non-uniform manner over the central part of the retina, being concentrated in the foveal area and in the regions immediately surrounding it. Following the removal of the filter, the regions of the retina containing the pigment under reference are lit up and flash into view. Such an effect can, of course, only be transitory. But it is worthy of note that it is restored in full strength when the filter is quickly put back and then again suddenly removed. The same procedure may be repeated as often as desired, thereby enabling the details of the retinal picture to be carefully studied. We are justified by these facts in inferring that what is actually perceived is a picture of the distribution of the visual pigment over the area of the retina under examination exhibiting the part of the spectrum incident on it and in which it functions as a receptor.

It thus emerges from the present investigation that the visual pigment which functions in the yellow sector of the spectrum and is responsible for the very high luminous efficiency and the very high power of colour discrimination indicated by Figs. 1 and 2 for that part of the spectrum is quite distinct from the pigments which function in the red and green sectors of the spectrum and is not a mere superposition of these two pigments functioning jointly. The identification of that pigment presents a problem which will not be discussed here. But

a useful hint is furnished by the observations which indicate that the pigment has *two* maxima of absorption, one between 540 m $\mu$  and 560 m $\mu$ , another between 560 m $\mu$  and 590 m $\mu$ , the latter being much the more pronounced of the two. Incidentally, it may also be remarked that the concept of three visual pigments or three fundamental sensations which forms the core of the Young-Helmholtz theory of vision is contradicted by the results of the present study and is therefore unsustainable.

### DUPLEX ORIGIN OF PETROLEUM

**T**HEORIES regarding the origin of petroleum are largely based on arguments advanced from the geological point of view. The organic chemical arguments derived from an investigation of the composition of petroleum (also natural gas, waxes, and bitumens) have been generally neglected.

According to Sir Robert Robinson there are convincing evidences to show that petroleum hydrocarbons are both biogenic and abiogenic, the latter portion being very much the older, probably by a factor of four or five times the maximum hitherto contemplated for biogenic petroleum.

The evidence for the biogenesis of petroleum is incontrovertible; but this may only apply to a part of the material. The indications of biogenesis are clear in young oils, less in evidence in those of middle age, and all but absent in the older crudes. The advocates of hundred per cent biogenetic origin assume that organic matter laid down in the sediments could be modified at quite moderate temperatures and pressures in the course of ages until it became the ancient petroleum which is described as 'crude' oil. The apology for the improbabilities that have to be accepted is the large time-scale involved, perhaps 400-500 million years. Actually it cannot be too strongly emphasized that petroleum does not present the composition picture expected of modified biogenic products and all the arguments from the constituents of ancient oils fit equally well, or better, with the conception of a primordial hydrocarbon mixture to which bioproducts have been added.

Recent investigations by improved chromatographic techniques have provided more precise knowledge of the constituents of petroleum in the lower ranges. It emerges that the straight-chain hydrocarbons always predominate over any one of the branch-chain isomers. Further, an examination of the nature of branch-chain hydrocarbons in the smaller carbon numbers (C<sub>5</sub>-C<sub>8</sub>) and of their quantitative relation to the corresponding *n*-alkane suggests that the branch-chain hydrocarbons could have been derived by isomerization processes. These have apparently been accompanied by *cyclodehydrogenation*, for example, *n*-hexane to 2-methylpentane and methylcyclopentane, *n*-heptane to 2- and 3-methylhexane, methylcyclohexane and then to dimethylcyclopentane.

It may also be that certain minor constituents are best regarded as the outcome of synthesis. For example, adamantane as arising from cyclopentadiene by dimerization, reduction and then pyrolysis. Moreover, the absence of oxygenated compounds and of olefines is indicative of a hydroforming type of operation. Aromatic hydrocarbons, thiophenes, and pyridines survive because of their relative high degree of resistance to hydrogenation.

According to Sir Robert Robinson it is supposed that the primordial oil was used as a source of carbon by primitive organisms. These contributed components to the oil and, later phytoplankton and land plants did likewise.

Before coming to any definite conclusion about the origin of petroleum the above points have to be seriously taken into consideration.—(Nature, 1963, 199, 113.)



ANALYSIS OF SAINT VENANT TORSION FOR REGULAR POLYGONAL  
CROSS-SECTIONS

AKELIA KAMESWARA RAO

*Department of Aeronautical Engineering, Indian Institute of Science, Bangalore-12, India*

## 1. INTRODUCTION

SETHU analysed the Saint Venant torsion of a prismatic bar whose cross-section is an  $n$ -sided regular polygon by mapping the polygon on to a unit circle. The procedure was elaborate and the computation, if numerical results are desired, would be substantial. A simple exact solution is now presented for the same problem.

To take advantage of the cyclic character of the regular polygon, the solution is initially taken as a series in polar co-ordinates. However, to facilitate satisfaction of the boundary conditions on the straight edges, it is converted into polynomials in Cartesian co-ordinates. Thereafter a very simple procedure is applied to obtain systematic convergence and accurate results with only a few terms of the series. It is found that the true values of the torsional stiffness and maximum stress are rapidly approached from below.

The solution for the equilateral triangle ( $n = 3$ ) is easily determined in the well-known closed form. Numerical examples are given for the square and the hexagon for which values from alternative analyses are available for comparison.

Series solutions in polar co-ordinates were used before to analyse torsion and bending involving straight boundaries.<sup>2-4</sup> However, in these contributions, the constants of the series were determined mostly by collocation and sometimes by least squares procedures whose limitations, particularly in the matter of systematic convergence and computational labour, are too well known to need further discussion. The analytical procedure now used eliminates the disadvantages of the above two methods. It is simple and ensures systematic and rapid convergence with relatively little computation.

Our method may be described as one of generating simple harmonic polynomials to deal with straight edge boundary conditions. As such it finds wide application in dealing with rectilinear fields governed by Laplace, Poisson and biharmonic type equations. This procedure appears to have been effectively exploited for the first time in the study of diffusion of loads

into swept panels.<sup>5</sup> It has since been applied to a wide range of problems as in references 6 and 7 and in other work to be published.

## 2. SOLUTION

Referring to the regular polygon of  $n$ -sides in Fig. 1, considerations of symmetry would

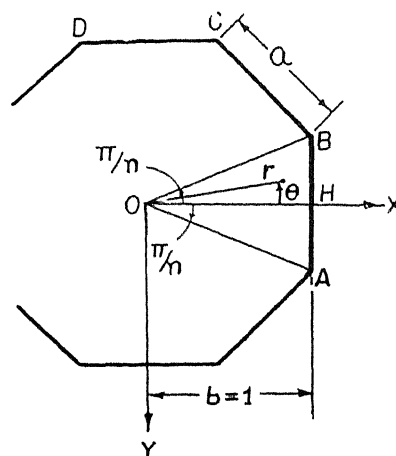


FIG. 1

indicate that the St. Venant torsion problem for such a cross-section is solved when a stress function  $\psi$  is determined in the triangular region AOB to satisfy the differential equation

$$\nabla^2 \psi = 2 \quad (1)$$

and the boundary conditions,

$$\psi_{,\theta} = 0 \text{ on } OA, OB \quad (\theta = 0, \pi/n) \quad (2)$$

and

$$\psi = 0 \text{ on } AB \quad (x = b). \quad (3)$$

Without any loss of generality, one may, for convenience, put  $b = 1$  and  $a = 2 \tan \pi/n$ . A solution to identically satisfy Eqs. (1) and (2) can be written down as

$$\psi = \psi_0 + \sum_{m=1}^{\infty} (-1)^m A_m r^{mn} \cos mn\theta. \quad (4)$$

Application of the second boundary condition, Eqn. (3), will determine the constants  $A_m$  and  $\psi_0$ .  $r \cos mn\theta$  can be expanded into polynomials in  $x$  and  $y$  if either  $mn$  is a positive

TABLE I  
Details of solution for square section

Sl. No.	Type of solution	$A_5 \times 10^5$	$A_4 \times 10^4$	$A_3 \times 10^3$	$A_2 \times 10^2$	$A_1 \times 10^1$
1	Soln. with 1 term	..	..	..	..	0.83333333
2	2 "	..	..	..	0.12755102	0.89285714
3	3 "	..	..	0.04984051	0.16447368	0.90460526
4	4 "	..	0.02907996	0.07920827	0.17821861	0.90837071
5	5 "	0.02056817	0.05529571	0.09514961	0.18432020	0.90992376
6	Exact values from Eqns. (157) and (160) in Ref. 8					

Sl. No.	Type of solution	$\psi_0$	Stiffness ( $J/a^4$ )		Maximum stress ( $\sigma/G\theta'$ )	
			Value	Error %	Value	Error %
	Soln with					
1	1 term	0.58333333	0.1361111	3.177	1.3333333	1.281
2	2 „	0.58801020	0.1394700	0.788	1.3469388	0.273
3	3 „	0.58886563	0.1401375	0.313	1.3492824	0.100
4	4 „	0.58913118	0.1403577	0.156	1.3499948	0.047
5	5 „	0.58923900	0.1404514	0.090	1.3502813	0.026
6	Exact values from Eqns. (157) and (160) in Ref. 8		0.1405777		1.2506294	

TABLE II  
Details of solution for regular hexagonal section

Sl. No.	Type of solution	$A_5 \times 10^5$	$A_4 \times 10^4$	$A_3 \times 10^3$	$A_2 \times 10^2$	$A_1 \times 10^1$
1	Soln. with 1 term	..	..	..	..	0.33333333
2	2 "	..	..	..	0.11675012	0.38461538
3	3 "	..	..	0.08427443	0.17365633	0.40114613
4	4 "	..	0.07966215	0.15693358	0.20367263	0.40840785
5	5 "	0.08679712	0.17803708	0.20982224	0.22199279	0.41521086
6	Exact values quoted by Conway (Ref. 3)					

Sl. No.	Type of solution	$\psi_0$	Stiffness ( $J/a^4$ )		Maximum stress ( $\sigma/G\theta' \delta$ )	
			Value	Error %	V value	Error %
	Soln. with					
1	1 Term	0.53333333	1.0079263	2.80	1.2000000	2.11
2	2 "	0.53729604	1.0243418	1.12	1.2167832	0.74
3	3 "	0.53846232	1.0295927	0.61	1.2213659	0.36
4	4 "	0.53895703	1.0318390	0.39	1.2232376	0.22
5	5 "	0.53929405	1.0333899	0.24	1.2246629	0.09
6	Ex ct values quoted by Conway (Ref. 3)		1.0359		1.22581	

integer or  $\theta$  is within the range  $(-\pi/4)$  to  $(+\pi/4)$ . For a regular polygon,  $mn$  being a positive integer, we make the expansion and rewrite the stress function and the Eqn. (3) as

$$\psi = \psi_0 - \frac{1}{2}(x^2 + y^2) + \sum_{m=1}^{\infty} (-1)^m A_m \sum_{p=0, 2, 4, \dots} (-1)^{p/2} C_p^{mn} x^{mn-p} y^p \quad (5)$$

and

$$\begin{aligned} [\psi]_{x=y=0} &= \psi_0 - \frac{1}{2}x^2 - \frac{1}{2}y^2 + \sum_{p=0, 2, 4, \dots} (-1)^{p/2} y^p \\ &\times \sum_m (-1)^m C_p^{mn} A_m \end{aligned} \quad (6)$$

where  $C_p^{mn}$  is the coefficient of  $y^p$  in  $(1+y)^{mn}$  and  $\psi_0$  is the value of  $\psi$  at the origin.

Eqn. (6) yields the following set of linear simultaneous equations in  $\psi_0$  and  $A_m$  whose solution completes the desired analysis:

$$\begin{aligned} p=0 &: \psi_0 + \sum_{m=1}^{\infty} (-1)^m A_m = \frac{1}{2} \\ p=2 &: \sum_{m=1}^{\infty} (-1)^m C_2^{mn} A_m = -\frac{1}{2} \\ p=4, 6, \dots &: \sum_{m \geq p/2} (-1)^m C_p^{mn} A_m = 0 \end{aligned} \quad (7)$$

In practice the series in the stress function is restricted to a finite number  $M$  and hence the order of Eqn. (7) is  $(M+1)$ .

The torsion constant  $(J/a^4)$  for the regular polygon is easily determined as

$$\begin{aligned} \frac{J}{a^4} &= \frac{2n}{(2 \tan \pi/n)^4} \int_{\Delta_{BOH}} 2 \psi dA \\ &= \frac{h}{4 (\tan \pi/n)^4} \int_{x=0}^1 \int_{y=0}^{x \tan \pi/n} \psi dx dy \\ &= \frac{n}{4 (\tan \pi/n)^3} \left[ \frac{1}{2} \psi_0 - \frac{1}{8} - \frac{1}{24} (\tan \pi/n)^2 \right. \\ &\quad + \sum_{m=1}^{\infty} (-1)^m (mn+2)^{-1} A_m \sum_{p=0, 2, 4, \dots} (-1)^{p/2} \\ &\quad \times C_p^{mn} (p+1)^{-1} (\tan \pi/n)^p \Big] \\ &= \frac{n}{4 (\tan \pi/n)^3} \left[ \frac{1}{2} \psi_0 - \frac{1}{8} - \frac{1}{24} (\tan \pi/n)^2 \right. \\ &\quad + \sum_{m=1}^{\infty} A_m (mn+1)^{-1} (mn+2)^{-1} \\ &\quad \times (\sec \pi/n)^{mn} \Big] \quad (8) \end{aligned}$$

The maximum stress, occurring at  $x = b$ ,  $y = 0$ , is

$$\frac{\sigma}{G\theta' b} = -1 + \sum_{m=1}^{\infty} (-1)^m mn A_m \quad (9)$$

### 3. EQUILATERAL TRIANGLE

It is readily verified that

$$\psi_0 = \frac{3}{2}, A_1 = \frac{1}{6}, A_2 = A_3 = \dots = 0 \quad (10)$$

### 4. SQUARE AND HEXAGON

Complete numerical analysis has been carried out for the square and the regular hexagon retaining successively 1, 2, 3, 4 and 5 terms of the series. The computations were done on a semi-automatic desk computer with  $10 \times 10 \times 20$  capacity. The constants  $\psi_0$  and  $A_m$ , the torsion constant  $(J/a^4)$ , and the maximum stress coefficient  $(\sigma/G\theta' b)$  (occurring at the middle points of the sides) are tabulated for the two cases in Tables I and II respectively. Exact values from

alternative solutions are also included for comparison. Large numbers of significant figures have been retained to facilitate further comparisons with other methods.

### 5. DISCUSSION

It is clear from the tables that the convergence of the solution is systematic and rapid. With only a few terms of the series one obtains very close lower bounds for the torsional stiffness as well as for the maximum stress in the section, the rate of convergence being faster for the maximum stress than for the torsional stiffness.

### 6. ACKNOWLEDGEMENTS

The author thanks Dr. P. Narasimha Murthy, for useful discussions and acknowledges the assistance received from S. A. Hussainy and S. S. Krishnamurthy in the preparation of the numerical examples.

1. Seth, B. R., "Torsion of beams whose cross-section is a regular polygon of  $n$ -sides," *Proc. Cambridge Philosophical Society*, 1934, **30**, 139.
2. Niedenfuhr, F. W. and Leissa, A. W., "The torsion of prismatic bars of regular polygonal cross-section," *Journal of the Aero-Space Sciences, Readers' Forum*, May 1961, **28** (5), 424.
3. Conway, H. D., "The approximate analysis of certain boundary value problems," *Journal of Applied Mechanics*, June 1960, **27**, 275.
4. Morley, L. S. D., "Bending of a simply supported rhomboidal plate under uniform normal loading," *Royal Aircraft Establishment Report No. Structures 271* (unclassified), August 1961.
5. Rao, Akella Kameswara, "Diffusion of loads into swept panels,—I" Report No. AE. 102 S, Indian Institute of Science, Bangalore 12, 1963.
6. —, "Exact analysis of St. Venant torsion and flexure of prismatic bars with arbitrary triangular and polygonal cross sections: I. Torsion of homogeneous solid bars," *Journal of the Aeronautical Society of India*, May 1963, **16** (2), 21.
7. — and Hussainy, S. A., "Exact analysis of St. Venant torsion and flexure of prismatic bars with arbitrary triangular and polygonal cross sections, II. Torsion of encased homogeneous bars, Report No AE. 103 S, Indian Institute of Science, Bangalore 12. To be published in the *Journal of the Aeronautical Society of India*.
8. Timoshenko, S. and Goodier, J. N., *Theory of Elasticity*, McGraw-Hill Book Company Inc., New York, Second Edition, 1951, p. 276.

## EFFECT OF FUNGICIDES ON PECTOLYTIC ENZYME ACTIVITY OF FUNGI

RAJENDRA K. GROVER

Department of Botany, Panjab University, Chandigarh-3

SEVERAL fungitoxic chemicals have been found to inhibit the respiratory enzyme activity of various fungi, thus demobilizing them to become effective parasites.<sup>1</sup> While studying the effect of fungicides and antibiotics on pectolytic enzyme secretion of brown rot fungi, *Sclerotinia fructicola* (Wint.) Rehm. and *S. laxa* Ader. and Ruhl., it was observed that the fungicides, that were effective in inhibiting the secretion of pectolytic enzymes of these fungi *in vitro*, were also effective in checking the brown rot of sour cherries in the field.<sup>2,3</sup> It appeared that fungi which produced pectolytic enzymes and invalidated host by their action could be controlled by the fungicides which checked or reduced the production of such hydrolytic enzymes. In rot-inducing fungi the production of pectolytic enzyme complex is inevitable and the importance of the pectolytic enzymes in the host-parasite interaction has been definitely established.<sup>4</sup> In the present account the effect of five fungicides on the production and activity of pectolytic enzymes secreted by *Sclerotinia sclerotiorum* (Lib.) d. By. and *Botrytis allii* Munn. *in vitro*, and also the effect of these fungitoxic chemicals on rotting of tissues brought about by these fungi has been presented. The production of pectolytic enzymes by *S. sclerotiorum* and *B. allii* has already been demonstrated.<sup>5,6</sup>

As a part of the investigations, the concentrations of fungicides required to inhibit the mycelial growth of the two fungi was determined by poison-food-technique,<sup>2</sup> using Ashour's synthetic agar medium in order to find the ED<sub>50</sub> values of each fungicide against the two organisms. The fungicides used were: Cycloheximide—Beta-[2-(3,5-dimethyl-2-oxocyclohexyl)-2-hydroxyethyl]-glutarimide; Dodine—*N*-dodecylguanidine acetate; Difolatan—*N*-(1,1,2,2-tetrachloroethylsulfenyl)-*cis*-delta-4-cyclohexene-1,2-dicarboximide; Nabam—disodium ethylenebis dithiocarbamate; and, Phaltan—*N*-trichloromethyl-thiophthalimide. All the chemicals were of technical grade of purity. For preparation of enzymic solutions, modified Ashour's synthetic medium containing ED<sub>50</sub> concentrations of each fungicide was used, and a suitable control without fungicide was also maintained. After growth of the two fungi on these media for 5 days at 25-27° C the mycelium was harvested, dried and weighed, and the

filtrates examined for enzymic activity. The enzymic activity was determined quantitatively by maceration tests using 5 potato discs (0.5 × 1.0 mm.) for each treatment.<sup>7</sup> The pH of the filtrates was adjusted to 5.0, as the enzymic activity has been found to be optimum at this pH.<sup>5,6</sup> The enzymic activity is expressed as the ratio between the dry mycelial weight (mg./ml. of the medium) and the time taken (minutes) for macerating the potato discs. All the experiments were repeated at least twice and the results are summarized in Table I.

TABLE I

Pectolytic enzyme activity of the filtrates of *Sclerotinia sclerotiorum* and *Botrytis allii* grown for 5 days on Ashour's synthetic medium containing fungicides at ED<sub>50</sub> concentration

Ashour's medium containing fungicide	<i>Sclerotinia sclerotiorum</i>		<i>Botrytis allii</i>	
	Fungicide concentration* (μg./ml.)	Enzymic activity	Fungicide concentration* (μg./ml.)	Enzymic activity
Cycloheximide	.. 6.5	1.24	5.0	0.89
Difolatan	.. 10.5	0.31	8.5	0.26
Dodine	.. 6.5	1.45	5.5	0.98
Nabam	.. 13.5	2.46	10.5	2.10
Phaltan	.. 12.5	0.21	9.0	0.13
No fungicide	.. ..	2.82	..	2.24

\* Average of three replicates tested twice. Fungicide concentration is the ED<sub>50</sub> value of each fungicide against the respective organism.

In all cases the enzymic activity in the filtrates of *S. sclerotiorum* was more than that of *B. allii*. Very little macerating activity was found when Phaltan or Difolatan were incorporated into the medium as compared with other chemicals. With Nabam, however, the enzymic activity was higher in proportion to its dry mycelial weight. Although the mycelial yields from media containing Phaltan or Difolatan were relatively higher than those containing Cycloheximide, Dodine, or Nabam, yet the enzymic activity was least in the former case, indicating thereby that Phaltan and Difolatan inhibited the production of enzymes more than the other chemicals tested.

It was further observed that in the filtrates of the two fungi grown on normal medium with-

out any fungicides, the high pectolytic activity could be reduced with the addition of Phaltan or Difolatan and not so by other chemicals tested. In other words, Phaltan and Difolatan not only acted upon the two fungi in inhibiting the production of enzymes *in vitro*, but also inactivated or decomposed the enzymes after having been secreted by them. Complete inactivation of the enzymes in the culture filtrates was obtained at relatively higher concentrations of these fungicides.

Tests were also carried out to determine the efficacy of these fungicides on checking the rot production on potato tissues. Potato cylinders cut aseptically with cork-borer of the size of 30 mm. long and 10 mm. in diameter were inoculated with spore suspensions of the two fungi separately and kept in moist chambers at 25-27° C. After 24 hours of inoculations five potato cylinders were sprayed with each of the fungicide at ED<sub>50</sub> concentration. The time taken for complete rotting of cylinders was noted. In case of *S. sclerotiorum* the potato cylinders were rotted completely after 26, 25, 12, 14, and 8 days of inoculation when sprayed with Phaltan, Difolatan, Dodine, Cycloheximide, and Nabam respectively. In another case when the potato cylinders were first dipped for 30 minutes in the same fungicides and then inoculated with the two fungi, the time taken for complete rotting was 29, 26, 18, 20, and 9 days for Phaltan, Difolatan, Dodine, Cycloheximide, and Nabam treatments respectively. The unsprayed or untreated potato cylinders rotted completely in 5 days. With *B. allii* the time taken for complete rotting of the potato cylinders with the two treatments mentioned above was invariably 2 to 3 days more than that taken by *S. sclero-*

*tiorum* in all cases and the untreated tissues rotted in 7 days. In both cases the initiation of rotting of potato tissues was delayed when these were treated or sprayed with either Cycloheximide or Dodine. However, once the rotting was initiated in such treated tissues, the completion was brought about quickly.

On the basis of above results it can be said that fungicides like Phaltan and Difolatan, which are not so toxic like Cycloheximide or Dodine in inhibiting the mycelial growths of the two fungi, are effective in checking the rot development in the tissues by the invasion of these organisms. This may be attributed to the property of these fungitoxic chemicals to inhibit and inactivate the pectolytic enzyme activity of these fungi and thus disturb host-parasite interaction. It is envisaged that this property of various fungitoxic chemicals may be utilizable in controlling rot diseases in the field. The metabolic behaviour of such fungitoxicants to bring about inhibition or reduction of pectolytic enzyme activity still remains to be studied.

Thanks are due to Prof. P. N. Mehra for facilitating these investigations.

1. Sisler, H. D. and Cox, C. E., "Physiology of Fungi toxicity," in *Plant Pathology—An Advanced Treatise*, Academic Press, N.Y., 1960, 2, 507.
2. Grover, R. K. and Moore, J. D., *Phytopathology*, 1962, 52, 876.
3. Grover, R. K., *Res. Bull. (N.S.)*, Punjab Univ., 1962, 13, 103.
4. Wood, R. K. S., "Pathogen factors in the Physiology of disease—Pectic Enzymes," in *Plant Pathology, Problems and Progress*, Univ. of Wis. Press, 1959, p. 100.
5. Echandi, E. and Walker, J. C., *Phytopathology*, 1957, 47, 303.
6. Vasudeva, R. S., *Ann. Bot.*, 1930, 44, 437.
7. Singh, R. K. and Wood, R. K. S., *Ibid.*, 1956, 20, 89.

## PLASTIC LASERS

THE Radio Corporation of America (RCA) Laboratories, Princeton, N.J., has announced the development and operation of the first plastic laser. The new laser consists of plastic fibres (each 15 in. long and about 20 times the diameter of a human hair) containing traces of the rare earth europium. To bring about the laser action the fibres are placed in a Dewar flask filled with liquid nitrogen, and exposed to intense flashes of ultra-violet light. The energy from the ultra-violet light is transmitted

by the fibres to chelates, which absorb the energy and transfer it to the europium atoms, causing them to emit bright flashes of red light.

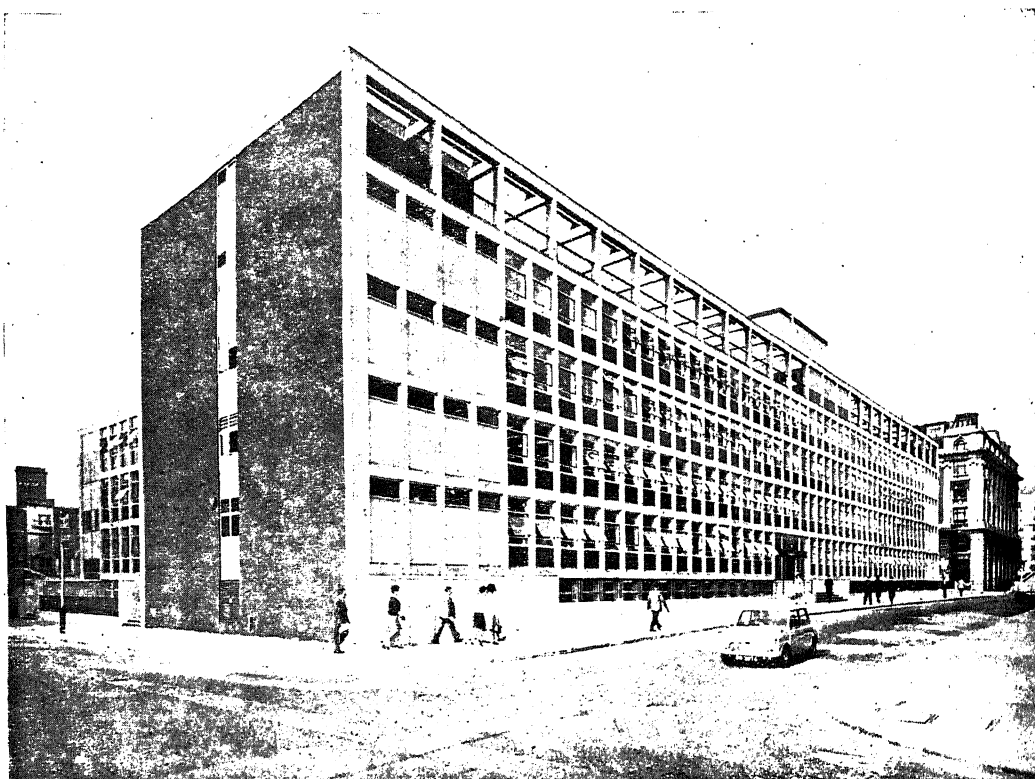
The fibres trap most of the light and force it to travel along their length. Each time such a flash occurs, it sweeps along the fibre and stimulates other flashes, all of which combine to create a single pulse of coherent light which bursts from the ends of the fibres with enormous intensity.—(*J. Frank. Inst.*, 1963, 275, 454.)

## GALLENKAMP TECHNICO HOUSE

**F**OUNDED in 1880 for the importation and distribution of German and Bohemian chemical glassware, Gallenkamp had, by the turn of the century, developed into an organisation for supplying all the requirements of the scientific laboratory.

matched by the growth of the Gallenkamp organisation from its modest origin to the position it now occupies as one of the world's major supply houses for all types of laboratory apparatus, instruments and equipment.

The apparatus for which Gallenkamp is most



Gallenkamp Technico House, Christopher Street, E.C. 2: Some 11,500 items including those sold under the trade names "Gallenkamp", "Technico" and "A.G." are actually held in stock here.

Incorporated as a Limited Company in 1900, the name Gallenkamp has been progressively earning a worldwide reputation as suppliers of not only laboratory apparatus and instruments but also of metallurgical assay and prospecting equipment.

Manufacturing departments which were started in the period 1911 to 1915 made it possible for the Company to maintain essential supplies after the outbreak of the first World War. Ever since that time the range of Gallenkamp speciality products of their own manufacture has been growing.

The development from the primitive prospecting equipment and laboratory apparatus of half a century ago to the sophisticated scientific instruments of the present day has been

famed falls into three main categories, viz., (i) laboratory electrically heated apparatus (furnaces, ovens, etc.), (ii) volumetric, fritted and blown glassware and (iii) a range of laboratory instruments.

A field in which Gallenkamp is playing an increasingly important role is in the design and production of instruments for automation of standardised tests. Two well-known examples are the "Gallenkamp" Automatic Adiabatic Bomb Calorimeter (Publication 595) and the "Asda" (Automatic Standard Distillation Apparatus). Supply of these "robots" so useful in science and industry is followed frequently by Gallenkamp engineers who are called in to advise and instruct on the uses of automated instruments.

## LETTERS TO THE EDITOR

### LARGE ANGLE RAYLEIGH SCATTERING OF 662 KEV. GAMMA RAYS

RAYLEIGH scattering of gamma rays has been calculated by various workers<sup>1,2</sup> using different approximations and each calculation predicts different dependence of scattering intensity on the atomic number of the scattering atom. Franz's<sup>1</sup> non-relativistic calculations which neglect the binding of the electrons in the intermediate state of scattering and make use of the Fermi-Thomas model of electron distribution have been extended by Moon<sup>1</sup> to give scattering intensity at large angles; these calculations show that the scattering cross-section is proportional to  $Z^3$ . Bethe and Levinger's<sup>2</sup> calculations use the relativistic wave-functions for the K-electrons to obtain a better approximation for large momentum transfers involved in large angle scattering and show that the scattering intensity may vary with atomic number as  $Z^2$  to  $Z^{3.5}$ . Recent calculations of Brown, Peierl and Woodward<sup>3</sup> which take into account the large momentum exchanges involved in large angle scattering, the effect of binding in the intermediate state and an atomic model based on the effective relativistic wave-functions of the K-electrons predict that the scattering cross-section varies with the atomic number as  $Z^2$  to  $Z^3$  depending upon the momentum transfer during the scattering process.

The differential scattering cross-section of coherent scattering of 662 keV. gamma rays from lead and tin at angles ranging from 15° to 90° have been measured by Mann<sup>4</sup> and the result are shown to agree better with the calculations of Brown *et al.* The coherent scattering cross-section of 662 keV. gamma rays from a number of elements at 105° have also been reported<sup>5</sup>. However, the available experimental data are scanty and it is difficult to derive any useful information about the variation of Rayleigh scattering cross-section with atomic number. We have measured the cross-section of Rayleigh scattering of 662 keV. gamma rays from Pb, Hg, W, I, Sn and Ag at angles 95°, 110° and 127° with a view to investigate the Z-dependence of Rayleigh scattering.

The experimental arrangement is shown in Fig. 1. Gamma rays from a 200 mc. Cs<sup>137</sup> source

S, were scattered from the scatterer Sc and the elastically scattered gamma rays were recorded with a single channel gamma ray spectrometer having 2" × 1½" diameter NaI (Tl) crystal D. The measurement of scattering cross-section consisted of measuring the intensity of coherent scattering, the strength of the source, the source-scatterer and the scatterer detector solid angles and the effective thickness of the scatterer.

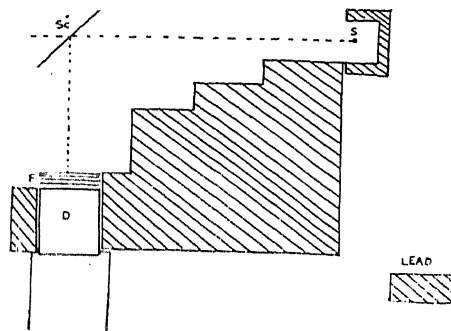


FIG. 1. Experimental set-up for large angle coherent scattering. S—200 mc.Cs<sup>137</sup> source; Sc—Sc tterer; F—Lead filters and D—NaI(Tl) detector.

The intensity of coherent scattering at any angle was determined from the analysis of scattered spectrum by the method described by Standing and Jovanovich.<sup>7</sup> The strength of the source used was measured in terms of the counting rate in the channels corresponding to the energies accepted in the main experiment; the absolute strength being not needed.

The solid angles subtended by the scatterer at the source was calculated from the known dimensions while the scatterer-detector solid angle was determined experimentally by replacing the scatterer with a weak Cs<sup>137</sup> source and comparing the weak source with the strong source actually used in the main experiment. The effective thickness of the scatterer was calculated by taking absorption in the scatterer into account.

The probability  $P$  of coherent scattering at any angle  $\theta$  is defined by

$$P = \sigma(\theta) \, n \, t.$$

where  $\sigma(\theta)$  is the differential cross-section of coherent scattering,  $n$  the number of atoms per c.c. and  $t$  the effective thickness of the scatterer.

P was determined experimentally by comparing the number of gamma rays elastically scattered from the scatterer to the number incident on it, while  $n$  and  $t$  were calculated for the given scatterer to obtain the value of  $[\sigma(\theta)]$ . At the energy and angles used in the present experiment the only other process which contributes to the elastic scattering in addition to the Rayleigh Scattering is the Nuclear Thomson scattering process<sup>4</sup>; the experimental demonstration of its existence and constructive interference with Rayleigh scattering has already been shown by one of the authors.<sup>5</sup>

The contribution of Nuclear Thomson scattering was calculated and subtracted from the measured scattering cross-section to get the value of Rayleigh cross-sections. The logarithm of  $[\sigma(\theta)]_{\text{Ray}}$  was plotted against  $\log Z$  for various elements at a given angle as shown in Fig. 2. The plot is a straight line and the slope

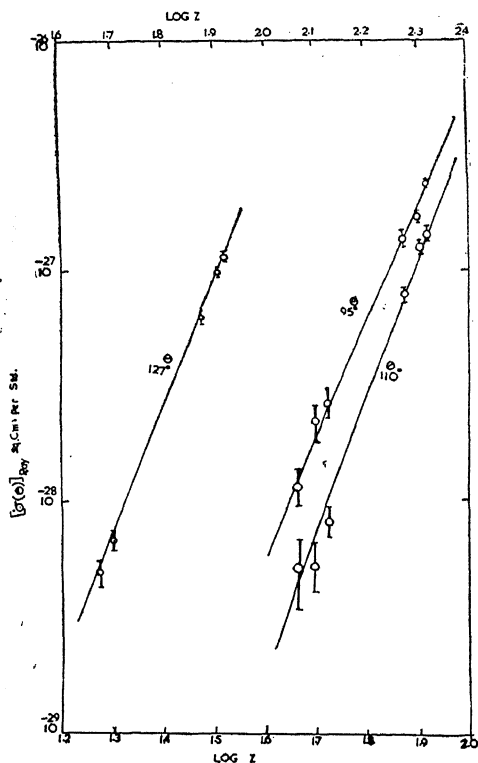


FIG. 2. The differential cross-section for Rayleigh scattering  $[\sigma(\theta)]_{\text{Ray}}$  in sq. cm. per. std. as a function of logarithm of atomic number  $Z$ . The scale at the top is for  $\theta = 127^\circ$  while the bottom scale is meant for  $\theta = 95^\circ$  and  $110^\circ$ . The errors shown are due to statistical fluctuations in the counting rate.

of the line gives the value of the power of  $Z$  on which the Rayleigh scattering cross-section

depends. It is seen that at the mean scattering angles of  $95^\circ$ ,  $110^\circ$  and  $127^\circ$  in the present experiment  $[\sigma(\theta)]_{\text{Ray}}$  is proportional to  $Z^{5.1 \pm 1.1}$ ,  $Z^{5.7 \pm 1.2}$  &  $Z^{5.7 \pm 1.2}$  respectively. The results contradict the predictions of Franz's calculations but are in fair agreement with the refined calculations of Brown, Peierls and Woodward showing that at large scattering angles which involve large momentum transfers, the assumptions of neglecting the electron binding in the intermediate state of scattering and Fermi Thomas distribution of electrons are not valid. Further work at intermediate scattering angles is in progress.

We are grateful to Prof. B. M. Anand for providing facilities to complete this work.

Department of Physics,

Punjab University,

Chandigarh-3, June 14, 1963.

S. ANAND.

M. SINGH.

B. S. SOOD.

1. Franz, W., *Z. Physik*, 1935, **98**, 314.
2. Levinger, J. S., *Phys. Rev.*, 1952, **87**, 656.
3. Brown, G. E., Peierls, R. E. and Woodward, J. B., *Proc. Roy. Soc.*, (London), 1954, **227A**, 51.  
Brenner, S., Brown, G. E. and Woodward, J. B., *Ibid.*, 1954, **227A**, 59.  
Brown, G. E. and Mayers, D. F., *Ibid.*, 1956, **234A**, 387.  
— and —, *Ibid.*, 1957, **242A**, 89.
4. Moon, P. B., *Proc. Phys. Soc.*, 1950, **63A**, 1189.
5. Mann, A. K., *Phys. Rev.*, 1956, **101**, 4.
6. Cindro, N. and Ilakovac, K., *Nucl. Phys.*, 1958, **5**, 647.
7. Standing, K. G. and Jovanovich, J. V., *Canad. J. Phys.*, 1962, **40**, 622.
8. Sood, B. S., *Proc. Roy. Soc.*, London, 1958, **247A**, 375.

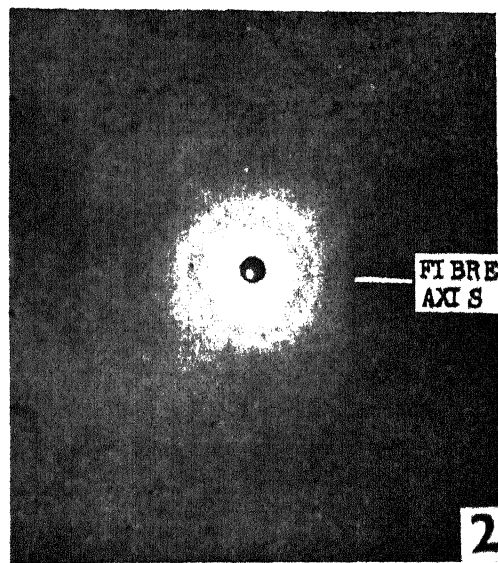
#### THE STRUCTURE OF THE SHEATH IN *LYNGBYA MAJUSCULA* HARVEY EX GOMONT

The present communication deals with the fine structure of the sheath of blue-green alga, *Lyngbya majuscula* Harvey ex Gomont, which was collected from Okha on the Western Coast. The specimens for electronmicroscopical studies were prepared by direct hydrolysis with N HCl at  $60^\circ\text{C}$ . after a preliminary osmium tetroxide fixation. The material was observed under a Philips Electronmicroscope after shadowing with palladium at an angle of about  $20^\circ$ . The X-ray diffraction patterns were taken with Philips X-ray diffraction unit 1010.

Figure 1 shows a fibrillar structure of the sheath. The longitudinal fibrils, i.e., those that are parallel to the axis of the filament, appear to be uniformly arranged and sometimes so closely packed that the sheath appears to be



smooth. At some places, occasional twisting of one microfibril around its neighbouring one is also observed. The transverse fibrils running across the filament axis also show closely packed arrangement (Fig. 1, T). The microfibrils are about 110 to 135 Å in diameter.



FIGS. 1-2. Fig. 1. Electron micrograph of hydrolysed mucilage of *Lyngbya majuscula* Harvey ex Gomont (Scale 1  $\mu$ ). Fig. 2. X-ray diffraction pattern of the same material (unhydrolysed).

Although the sheath in *Lyngbya majuscula* is also fibrillar as in other blue-green algae<sup>1,2,4-8</sup> the microfibrils show closely packed longi-

tudinal and transverse arrangement. X-ray diffraction patterns (Fig. 2) indicate a random orientation of the molecular chains of cellulose material. However, the greater intensities of the rings, along the fibre axis as compared to the equatorial direction, suggest that although the cellulose chains are oriented at random, a greater part of the chains are arranged in the direction of the fibre.

The equatorial reflections of cotton cellulose at 5.4, 6.1 and 3.9 Å were found to be absent in *Lyngbya majuscula*. However, the first ring that appeared in the diffraction pattern of *Lyngbya majuscula* near about 2.6 Å is attributable to the first strong reflection in the layer line of cellulose indexed as (0 4 0).<sup>3</sup> Moreover the Debye Scherrer powder pattern of *Lyngbya majuscula* showed that the sheath material was essentially of cellulose.

The deposition of the molecular chains in the present form differs from that of *Valonia* and *Cladophora*, where the molecular chain axes cross each other almost at 90° along the cell wall.<sup>3</sup>

The present observations indicate that cellulose molecular chains in *Lyngbya majuscula* are arranged with their molecular chain axis perpendicular to the cell wall. The sheath is made up of equatorial plane of cellulose molecular units, their arrangements being partially random, thus giving more a powder pattern than a fibre pattern.

The authors are thankful to Dr. C. Dakshinamurti for his keen interest in the work.

S. C. MEHTA.

Indian Agric. Res. Inst., S. C. DAS.

New Delhi-12, G. S. VENKATARAMAN.

February 9, 1963. R. CHANDRA.

1. Bringmann, G., *Z. wiss. Mikr.*, 1951, **60**, 83.
2. Frey, Wyssling, A. and Stetcher, H., *Z. Zellforsch.*, 1954, **39**, 515.
3. Preston, R. D., *The Molecular Architecture of Plant-Cell Walls*, Chapman & Hall, 1952, pp. 42, 91-112.
4. Ris, H. and Singh, R. N., *J. Biophys. Biochem. Cytol.*, 1961, **9**, 63.
5. Singh, R. N., *Proc. Europ. Conf. Electron. Microscopy*, Ghent, Belgium, 1954, pp. 1-5.
6. Sun, C. N., *Bull. Torrey Bot. Club.*, 1961, **88**, 106.
7. Venkataraman, G. S. and Mehta, S. C., *Rev. Algol.*, 1962, **6**, 92.
8. —, — and Goyal, S. K., *Phykos*, 1962, **1**, 36.

## ACTION OF SODIUM BOROHYDRIDE-LEWIS ACID COMPLEXES ON ACETALS AND KETALS

THE non-reduction of the acetal and ketal groups with lithium aluminium hydride (LAH) has been utilised<sup>1</sup> for the protection of carbonyl groups during LAH reductions of ketesters or ketoacids. We had occasion to reduce ketocarboxylic acids and in place of LAH we used sodium borohydride (SBH)-Lewis acid complexes. Despite the strict adherence to the reduction conditions<sup>2</sup> and ketalising the carbonyl group, the reduction product was always found to contain appreciable amounts of the corresponding ethoxycarbinols in addition to the expected ketocarbinols. Subsequently it was established that these ethoxycarbinols were formed as a result of the side reaction—the action of SBH-Lewis acid complexes on the ketal group.

Though ketals and acetals are stable to LAH, combinations of LAH- $\text{AlCl}_3$ <sup>3,4</sup> and LAH- $\text{BF}_3$ <sup>5</sup> are known to bring about the hydrogenolysis of ketals and acetals to the corresponding ethers. In order to find out to what extent ketals and acetals are affected by SBH-Lewis acid combinations, under the normal reduction conditions employed, the present investigation was undertaken.

The results clearly indicate that ketals and acetals are hydrogenolysed by SBH-Lewis acid complexes also giving the corresponding hydrogenolysed products in fairly high yields, even under the mild conditions employed during these reductions.

Eliel and co-workers<sup>3,4</sup> have reported that the yield of the hydrogenolysed product varies widely depending on the amount of  $\text{AlCl}_3$  used with LAH. It is very likely that with the use of higher ratios of Lewis acids with SBH, the yield of the hydrogenolysed products of acetals and ketals can be substantially increased so as to make it a practicable method of obtaining ethers starting from aldehydes and ketones.

\* This and other aspects of the problem are being investigated and details will be published in due course.

National Chem. Laboratory, N. JANAKI.  
Poona-8, July 18, 1963. K. D. PATHAK.  
B. C. SUBBA RAO.

1. Gaylord, N. G., *Reduction with Complex Metal Hydrides*, Interscience Publishers Inc., New York, 1956, p. 673.
2. Brown, H. C. and Subba Rao, B. C., *J. Am. Chem. Soc.*, 1955, **77**, 3164; 1956, **78**, 2582.
3. Eliel, E. L. and Rerick, M. N., *J. Org. Chem.*, 1958, **23**, 1088.
4. —, Badding, V. G. and Rerick, M. N., *J. Am. Chem. Soc.*, 1962, **84**, 2371.
5. Abdarnur, A. R. and Issidorides, C. H., *J. Org. Chem.*, 1962, **27**, 67.

TABLE I

Compound reduced	Reducing agent	Reduction product	B.P. °C.	Yield %
1 Acetophenone diethyl ketal	SBH- $\text{BF}_3$ (1:1) SBH- $\text{AlCl}_3$ (3:1)	Ethyl $\alpha$ -phenethyl ether Do.	88-90°/31 mm. Do.	72 52
Methyl <i>n</i> -propyl diethyl ketal	SBH- $\text{BF}_3$ (1:1)	2-Ethoxypentane	107-9°/720 mm.	52
Benzaldehyde diethyl acetal	SBH- $\text{BF}_3$ (1:1) SBH- $\text{AlCl}_3$ (3:1)	Benzyl ethyl ether Do.	75-77°/23 mm. 76-78°/23 mm.	65 50
Heptaldehyde diethyl acetal	SBH- $\text{BF}_3$ (1:1)	Heptyl ethyl ether	125-27°/720 mm.	47
Cyclopentanone ethylene ketal	SBH- $\text{BF}_3$ (1:1)	2-Cyclopentyl oxy ethanol	92-94°/20 mm.	59
Cyclohexanone ethylene ketal	SBH- $\text{BF}_3$ (1:1)	2-Cyclohexyl oxy ethanol	98-100°/14 mm.	55

The reduction conditions employed in the present study are the same as those employed by Brown and Subba Rao,<sup>2</sup> viz., use of 50-100% excess of the reagent in diglyme at room temperature (25-30° C.) for 2-3 hrs. A few selected aldehydes and ketones were converted to their acetals and ketals and these were subjected to the action of SBH- $\text{AlCl}_3$  and SBH- $\text{BF}_3$ . The reaction products were isolated and characterised by the usual methods. The results obtained are summarised in Table I.

## SELECTIVE REDUCTION OF CARBOXY AND CYANO GROUPS IN THE PRESENCE OF CARBONYL GROUPS

COMPLEX METAL HYDRIDES like lithium aluminium hydride (LAH) are normally used for the reduction of all functional groups like carbonyl, carboxy and cyano groups, while sodium borohydride (SBH) is used for the selective reduction of carbonyl groups in the presence

of carboxy and cyano groups. The selective reduction of carboxy or cyano group without affecting the carbonyl group is not possible, at least directly. Such selective reductions have, however, been effected<sup>1</sup> by first protecting the carbonyl group (by forming ketal) and then reducing the cyano or carboxy groups with lithium aluminium hydride and then regenerat-

pressure. The residue was worked up in the usual way to isolate the pure keto alcohol or keto amine under study. The reduction product was characterised by analysis and I.R. followed by the preparation of 2:4 DNP derivative. The results thus obtained in the selective reduction of a few selected keto carboxylic acids and keto nitriles are summarised in Table I.

TABLE I

Compound reduced	Major reduction product	Yield %	Phy. consis. m.p./b.p. °C.	2, 4 DNP derivative m.p. °C.
1 <i>p</i> -Benzoyl benzoic acid ..	$C_6H_5COC_6H_4-CH_2OH$	59.0	m.p. 45°C.	241°
2 $\beta$ -Benzoyl propionic acid ..	$C_6H_5COCH_2CH_2CH_2OH$	60.0	b.p. 63-64 °C./3 mm.	137°
3 Benzoyl formic acid ..	$C_6H_5COCH_2OH$	50.4	b.p. 111-13 °C./10 mm.	190-91°
4 Levulinic acid ..	$CH_3COCH_2CH_2CH_2OH$	64.3	b.p. 100°C. 30 mm.	124°
5 Benzoyl cyanide ..	$C_6H_5COCH_2NH_2$ $C_6H_5COCH_2NH_2HCl$	60.0	b.p. 162-63 °C./710 mm. m.p. 185 °C. (decomp.)	165-67°

ing the keto group to give the required keto alcohols and keto amines.

We wish to report the successful application of the acidic type reducing agent diborane<sup>2</sup> for the direct selective reduction of keto carboxylic acids and keto nitriles to the corresponding keto alcohols and keto amines in fairly good yields. In their rate studies, Brown and Korytnk<sup>3</sup> had observed that the attack of diborane was in the following order: Carboxylic acid > olefin > ketone > nitrile when a limited amount of diborane was allowed to react with a mixture of two compounds having two different functional groups. But we have found that both carboxylic acid and nitrile functional groups react faster than ketones, resulting in the formation of keto alcohols and keto amines as the predominant reaction product when reacted with only the requisite amount of diborane. The success of the method depends on following scrupulously anhyd. conditions in carrying out the reactions (at room temperature) and then yields are in the range 50-80% (based on the starting material).

Following is the recommended procedure: The apparatus is flamed and then cooled while a slow stream of dry nitrogen flows through it. Calculated amount of gaseous diborane, generated by adding a solution of sodium borohydride in diglyme to a solution of borontrifluoride in the same solvent, was passed slowly, into a cooled solution of the keto acid or keto nitrile (in diglyme or THF) under anhyd. conditions. After allowing the reaction mixture to stand for 2-3 hours at R.T. with occasional shaking, it was then hydrolysed with methanolic HCl and the solvents removed under reduced

This method has been found applicable to both aromatic and aliphatic systems.

National Chem. Laboratory, B. C. SUBBA RAO.  
Poona-8, July 18, 1963. G. P. THAKAR.

1. Gaylord, N. G., *Reduction with Complex Metal Hydrides*, Interscience Publishers, Inc., New York, 1956, p. 673.
2. Brown, H. C. and Subba Rao, B. C., *J. Org. Chem.*, 1957, **22**, 1135; *J. Am. Chem. Soc.*, 1960, **82**, 681.
3. — and Korytnk, W., *J. Am. Chem. Soc.*, 1960, **82**, 3866.

#### ERYTHROCYTIC GLUCOSE-6-PHOSPHATE DEHYDROGENASE IN VARIOUS ANIMAL SPECIES

DEFICIENCY of the enzyme, glucose-6-phosphate dehydrogenase (G-6-PD) in human erythrocytes has been shown to be genetically linked.<sup>1-3</sup> Childs *et al.*<sup>3</sup> have demonstrated after an exhaustive genetical study that G-6-PD deficiency is sex-linked with incomplete penetrance. The pivotal role played by this enzyme in the economy of red cells through oxido-reduction processes is well known.

During our genetical studies on animals, we became interested to find out whether the deficiency of G-6-PD existed in erythrocytes of Indian animal species. We have recently reported the total absence of G-6-PD in erythrocytes of sheep and goat.<sup>4</sup> Therefore, an investigation was undertaken to determine the G-6-PD activity in the erythrocytes of other animal species like horse, donkey, mule, dog, pig and rabbit.

The bloods were collected from various species in 3-8% sodium citrate and studies were made on fresh samples. Enzyme activity was determined by Motulsky's technique as outlined by Baxi *et al.*<sup>5,6</sup> The time for the decolorization of the 'redox' dye, brilliant creasyl blue was recorded. The samples taking longer than 120 minutes were considered deficient.

The results of the G-6-PD activity in terms of time taken for decolorization are given in Table I.

TABLE I

*Glucose-6-phosphate dehydrogenase activity in terms of time of decolorization of various animal species*

Species	No. of Animals	Time Range of Decolorization (in minutes)	No. of Deficient (>120 minutes)
Horse ..	35	45-60	Nil
Donkey ..	1	>180	1
Mule ..	5	50-60	Nil
Dog ..	36	40-60	5
Pig ..	105	45-90	29
Rabbit ..	50	50-90	Nil

The results of the first three species show an interesting feature. Although all the three species are related closely (family *Equidae*), the only donkey blood sample showed less enzyme activity as compared to horse and mule. The G-6-PD activity (in terms of time of decolorization) in horse and mule is more or less same. Horse erythrocytes had higher activity of this enzyme as compared to that in man where time of decolorization is normally more than 60 minutes. This enzyme was found completely absent in 4 out of 25 male and 1 out of 11 female dogs. Among pigs, all animals studied were males and this enzyme was completely absent in 29. Rabbits, numbering 50, showed a normal enzyme activity.

It is not known whether this enzyme in above-mentioned animal species is genetically controlled and if so, whether it is sex-linked as in human beings. It was also observed in some samples from pigs and dogs that there was regaining of the colour of the dye after 4-6 hours of decolorization. This phenomenon of 'regaining' so far has not been observed in G-6-PD test in human samples. More work to elucidate the 'regaining' phenomenon is in progress.

We wish to thank Dr. (Mrs.) Kamal J. Rana-dive and Prof. V. R. Khanolkar. for their kind interest in the investigation. Thanks are also due to Drs. S. P. Hattangadi, G. R. Murkibhavi

and P. V. Naik of Bombay Veterinary College for their kind co-operation.

Blood Group Ref. Centre and A. J. BAXI.

Human Variation Dept., S. N. NAIK.

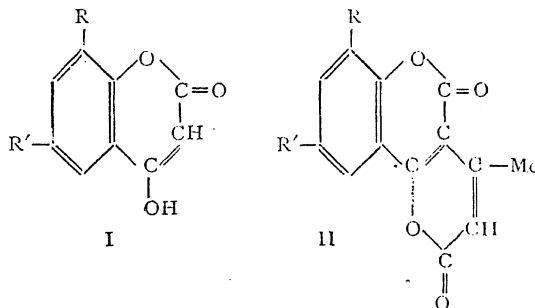
Indian Cancer Research Centre, H. M. BHATIA.  
Parel, Bombay-12,

August 1, 1963.

1. Allison, A. C., *Nature (Lond.)*, 1906, **186**, 531.
2. Beutler, E., *Blood*, 1959, **14**, 103.
3. Childs, B., Zinkham, W., Browne, E. A., Kimbro, E. L. and Torbert, J. V., *Bull. John Hopkins Hosp.*, 1958, **102**, 21.
4. Khanolkar, V. R., Naik S. N., Baxi, A. J. and Bhatia, H. M., *Experientia*, July 22, 1963.
5. Baxi, A. J., Balakrishnan, V. and Sanghvi, I. D., *Curr. Sci.*, 1961, **30**, 16.
6. —, Undevia, J. V. and Sanghvi, I. D., *Indian J. Med. Sci.*, 1963, **17**, 493.

### SYNTHESIS OF 3, 4-COUMARIN-PYRONES

4-HYDROXY COUMARIN<sup>1</sup> (Ia) has been condensed successfully with ethyl acetoacetate in presence of anhydrous aluminium chloride to give coumarino (3', 4', 5, 6)-4-methyl- $\alpha$ -pyrone (IIa) (crystallised from benzene as silky needles, m.p. 245-46°; found C, 68.63; H, 3.90; C<sub>13</sub>H<sub>8</sub>O<sub>4</sub> requires C, 68.42; H, 3.51%). This is the first instance of a coumarino- $\alpha$ -pyrone with pyrone ring built on heterocyclic part of the coumarin molecule. The same product was obtained when the condensation was carried in presence of phosphorus oxychloride and also in presence of 80% sulphuric acid, but the yields were comparatively low with these condensing agents.



a, R = H ; R' = H

b, R = H ; R' = Me

c, R = Me ; R' = H

The possibility of the compound (IIa) to be coumarino-2-methyl- $\gamma$ -pyrone is ruled out as it failed to condense with piperonal in presence of sodium ethoxide to form styryl derivative

a characteristic property of 2-methyl- $\alpha$ -pyrone<sup>1</sup>). The coumarino- $\alpha$ -pyrone (II a) dissolved slowly in 10% aqueous solution of sodium hydroxide on heating on boiling water-bath and was reprecipitated by acidification, but on boiling it with 20% aqueous solution of sodium hydroxide for three hours, both the heterocyclic rings of the coumarino- $\alpha$ -pyrone (II a) got ruptured with the formation of salicylic acid, which was isolated by acidification of the solution.

4-Hydroxy-6-methyl coumarin<sup>1</sup> (I b) and 4-hydroxy-8-methyl coumarin<sup>1</sup> (I c) also condensed smoothly with ethyl acetoacetate in presence of anhydrous aluminium chloride to give coumarino- (3',4',5,6)-4,6'-dimethyl- $\alpha$ -pyrone (II b), crystallised from benzene as needles, m.p. 197-98°; found C, 69.5; H, 4.4;  $C_{17}H_{10}O_4$  requires C, 69.41; H, 4.13% and coumarino- (3',4',5,6)-4,8'-dimethyl- $\alpha$ -pyrone (II c), crystallised from benzene as thin plates, m.p. 202-03°; found C, 68.9; H, 4.4;  $C_{17}H_{10}O_4$  requires C, 69.41; H, 4.13%.

ORGANIC CHEM. RES. LAB., JINJIY PATELL,  
Institute of Science, R. N. USGAONKAR,  
Bombay, May 20, 1963

1. Prepared by the method of Shah, Bose and Shah, *J. Org. Chem.*, 1960, 25, 677.
2. Holman, Baker and Morton, *J. Chem. Soc.*, 1923, p. 2659; King and Robertson, *Ibid.*, 1934, p. 1034; Chakravarti, *J. Ind. Chem. Soc.*, 1931, 8, 129; *Ibid.*, 1936, 13, 619.

### AN IMPROVED FERRIC CHLORIDE METHOD FOR THE RAPID DETERMINATION OF SERUM TOTAL CHOLESTEROL

The  $FeCl_3$  method of Zlatkis, Zak and Boyle (1953), for estimation of total cholesterol in Serum has been variously modified. Leffler and McDougald (1963) described a procedure in which a stable  $FeCl_3$  reagent was used in conjunction with  $H_2SO_4$  to produce colour on an iso-propanol extract of serum.

The defects inherent in extracts derived from alcoholic precipitation of serum proteins are also seen in the iso-propanol extract. It is opaque and coloured by the bilirubin of serum. Leffler and McDougald gave details of a somewhat cumbersome procedure to free extracts of bilirubin content. It is felt that a simpler technique would be of advantage to laboratories handling a variety of sera. Such a technique is presented below.

**Principle.**—Serum is treated with methanol and fuller's earth. The clear colourless extract is mixed with  $FeCl_3$  reagent and  $H_2SO_4$ . The resulting ruby red colour is measured at 530 m $\mu$ . A standard solution of cholesterol in methanol is similarly treated for comparison.

#### METHOD

##### Reagents

1. *Methanol, Merck Pro analysis or Analar.*—L.R. Methanol should be purified by adding 2 g. of meta-phenylene diamine to 500 ml. and distilling after keeping in the dark for one week.
2. *Stock cholesterol standard.*—A sample of cholesterol which had been thrice recrystallised from acetone is used to make a 0.1% solution (w/v) of cholesterol in methanol.
3. *Working cholesterol standard.*—8 ml. of stock standard are diluted to 100 ml. with methanol (1 ml. = 0.08 mg. of cholesterol).
4. *Ferric chloride colour reagent (according to Leffler and McDougald).*—500 mg. of  $FeCl_3 \cdot 6H_2O$  are dissolved in 500 ml. of glacial acetic acid which may be E. Merck, S. Merck, or of Analar quality. The reagent is stable when stored at room temperature.
5. *Sulphuric acid, analytical grade.*—ISI certified sulphuric acid is suitable.
6. *Fuller's earth.*—150 mg. quantities are put up in paper packets for future use. The available brands show difference in capacity to adsorb bilirubin. The proper material must therefore be selected by trial.

##### Procedure

To 0.2 ml. serum placed in a round-bottomed centrifuge tube, 4-8 ml. of methanol are added. With the mouth covered by tinfoil, the tube is given an occasional shake during an extraction period of 5 minutes. 150 mg. of fuller's earth are dumped in and mixed for a few seconds. The tube is then centrifuged for 3 minutes at 3,000 r.p.m.

2 ml. of the clear colourless supernatant are transferred to a 50 ml. conical flask. 2 ml. of cholesterol working standard are taken in another flask. 3 ml. of  $FeCl_3$  reagent are added and mixed well. With the flask held in a slanting position, 3 ml. of  $H_2SO_4$  are run along the side to form a layer at the bottom; the flask is then gently set aside. After a similar addition of sulphuric acid to all extracts, each flask is covered in turn with a funnel and

given a whirl when a brief but vigorous reaction is induced with the development of a ruby red colour.

The colour being stable for 15 minutes, measurements can be conveniently completed on eight samples of a batch. The colour intensity is read against reagent blank with Yellow-green filter (530 m $\mu$ ) in the Lumeteron or with No. 2 Yellow-green disc in the M.R.C. Photometer. Beer's Law holds to a concentration of 400 mg% of cholesterol.

The simplicity of the present technique would appeal to those familiar with the Zak (1957) procedure. There is no insistence on the use of E. Merck Acetic acid nor on the purification of Analar Acetic acid by refluxing over CrO<sub>3</sub> and distilling twice (Varley, 1960). The colour is maximal at start with practically no tinge of brown. There is no hindrance to immediate measurement as there are no trapped air bubbles to interfere.

Kingsley and Schaffert (1949) used fuller's earth to eliminate bilirubin in a chloroform extract of icteric serum. In the present case, fuller's earth clarifies the methanol extract besides ridding it of bilirubin.

We are thankful to Dr. A. B. Marikar, Director, Medical Service, Madras State, for permitting the publication of this paper.

Dept. of Biochemistry, A. N. RAMANATHAN.  
Stanley Medical College, MISS T. S. SAVITHRI.  
Madras-1, July 16, 1963.

1. Kingsley, G. R. and Schaffert, R. R., *J. biol. Chem.*, 1949, **180**, 315.
2. Leffler, H. H. and McDougald, C. H., *Amer. J. clin. Path.*, 1963, **39**, 311.
3. Varley, H., *Practical Clinical Biochemistry*, 2nd Edition, William Heineman, London, 1960, p. 218.
4. Zak, B., *Amer. J. clin. Path.*, 1957, **27**, 583.
5. Zlatkis, A., Zak, B. and Boyle, A. J., *J. Lab. clin. Med.*, 1953, **41**, 486.

#### HISTOCHEMICAL DEMONSTRATION OF ALKALINE PHOSPHATASE IN CANDIDA

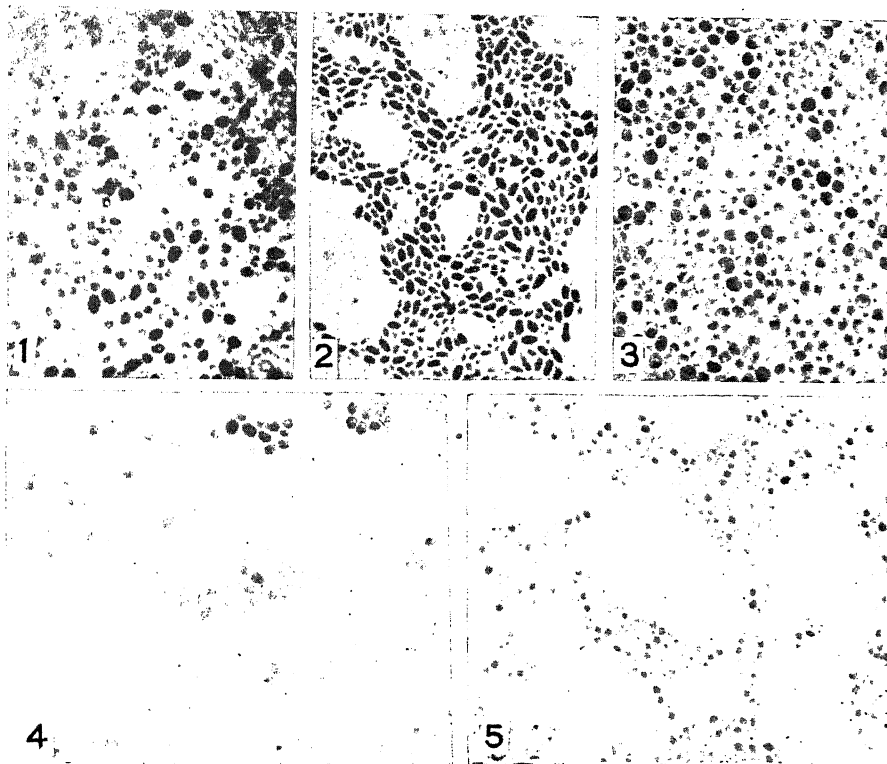
CONSIDERABLE amount of literature has accumulated on the histochemical localization of enzymes in the tissues of higher animals and plants. However, only isolated reports have appeared on the enzymes of micro-organisms. Sreevastava *et al.*<sup>1</sup> studied the phosphatase activity of *Salmonella typhosa* and its antigenic variants. Pradhan *et al.*<sup>2</sup> and Varma and Srinivasan<sup>3</sup> studied the alkaline phosphatase of *E. coli* and

*Aspergillus flavus* respectively. Bayliss *et al.*<sup>4</sup> demonstrated histochemically the alkaline phosphatase in bacteria and yeasts. They reported the presence of alkaline phosphatase in *Candida albicans*, and *Saccharomyces* species and its absence in *Cryptococcus* and *Geotrichum*. As a prelude to a detailed study a preliminary histochemical localization of alkaline phosphatase was attempted which yielded the results of this note.

Cultures maintained in glucose peptone agar slants were used for the study. Smears were prepared in the usual manner by allowing a suspension of the organism in distilled water to dry on microscope slides. The slides were fixed in chilled acetone and stained according to the method of Gomori.<sup>5</sup> Control experiments were carried out by incubating the slides simultaneously in a substrate free medium. After suitable incubation the slides were stained and examined for alkaline phosphatase.

All the tested organisms, viz., *Candida albicans*, *C. tropicalis*, *C. krusei*, *C. parapsilosis* and *C. guilliermondi* failed to show phosphatase during the first 3 hours of incubation, a period sufficient for its staining in the case of animal tissues. *C. tropicalis* showed faint activity after 4 hours incubation. But as the incubation continued for 12 to 15 hours the enzyme increased and the yeast cell stained well. Under identical conditions of incubation and other procedures more of the enzyme was contained in *C. tropicalis* (Fig. 1), *C. krusei* (Fig. 2) and *C. albicans* (Fig. 3) than in *C. guilliermondi* (Fig. 4) and *C. parapsilosis* (Fig. 5). Cultures younger than 18 hours and older than 10 days showed very poor enzyme formation as compared to those grown for 48 to 72 hours. But *C. guilliermondi* showed maximum contents after 24 hours growth at 37° C. No difference in activity was noticed between the mycelial phase and yeast phase or cultures incubated at different temperatures.

Absolutely no difference in activity of the enzyme was found in those treated with Nystatin (an antifungal antibiotic effective against *Candida*) along with the substrate at the start of the experiment. The concentration of Nystatin used was sufficient to inhibit the growth of the respective species, as evidenced by sensitivity tests. The organisms grown on phosphate media showed only very faint activity than those grown on phosphate free media. Alkaline phosphatase activity showed a noticeable increase when the organisms were grown in media to which was incorporated magnesium and manganese salts. But no



FIGS. 1-5

change was noticed by the addition of zinc or calcium salt to the culture media.

I am indebted to Shri A. S. Monie of the Physiology Department of this Institution for the valuable suggestions and to the Professor of Bacteriology and Principal, Medical College, Trivandrum, for the facilities given to carry out this investigation.

Department of Bacteriology, P. V. KURUP,\*  
Medical College,  
Trivandrum-11 (India),  
February 27, 1963.

\* Present address : Department of Medical Mycology  
Vallabhbhai Patel Chest Institute, Delhi-6.

1. Shrivastava, G. C., Ghatak, S. and Bhatnagar, S. S., *Enzymologia*, 1954, 17, 23.
2. Pradhan, D. S., Rege, D. V. and Sreenivasan, A., *Ibid.*, 1962, 24, 105.
3. Varma, T. N. R. and Srinivasan, *Ibid.*, 1954, 17, 116.
4. Bayliss, M., Glick, D. and Siem, R. A., *J. Bact.*, 1948, 55, 307.
5. Gomori, G., *Microscopic Histochemistry*, University of Chicago Press, 1953.

# COPPER MINERALS IN THE GNEISSES AND GRANULITES OF VISAKHAPATNAM, WALTAIR, ANDHRA PRADESH

MAHADEVAN,<sup>2</sup> MAHADEVAN AND SATHAPATHI<sup>3</sup> AND  
MURTY<sup>1</sup> studied rock types near Visakhapatnam,  
Waltair, and made no mention of the interesting  
copper encrustation or copper mineralisation  
under report except that Murty<sup>1</sup> recorded  
chalcopyrite in basic charnockites. The occur-  
rences are half a furlong east of circuit house  
and half a furlong east of Municipal Travel-  
lers' Bungalow in quarries and also in quarries  
behind Pharmacy Department, Andhra Uni-  
versity.

The various outcrops in these places look  
greenish due to malachite and on closer exami-  
nation show specks of sulphides. The rock  
types in which they occur are leucocratic,  
coarse-grained, usually unaltered, essentially  
consisting of quartz, felspar and garnet.  
Malachite is also present as disseminated films.

The thin sections and polished sections  
reveal that the rocks are highly gneissose and

granulose and the copper minerals occur in intergranular spaces and along cracks of the quartz. The copper minerals and the associated quartz belong to a subsequent paragenesis.

The copper mineralisation is primary with chalcopyrite, bornite and pyrite from which secondary minerals, covellite, idaite, and limonite are formed respectively. Further alteration resulted in malachite encrustation. The early chalcopyrite is rimmed by later pyrite when both of them occur together. The chalcopyrite and bornite association and their relative paragenesis has not been observed as both of them do not come together in the specimens examined. Covellite is a secondary product usually from chalcopyrite. The bornite alters to idaite. Both the primary and secondary sulphides form malachite on further alteration. It may be mentioned that malachite formation is not a widespread phenomenon.

Molybdenite is another important mineral observed. It is occurring as independent grains, flaky in habit, white in colour, strongly pleochroic, very high in reflectivity, and anisotropic with pleasing colours. There is a greenish colouration when observed in oil immersion under crossed nicols.

The minerals described both of copper and molybdenum belong to low temperature hydrothermal-pneumatolytic paragenesis. The alteration of the chalcopyrite and bornite gave rise to the formation of minerals like covellite and idaite.<sup>1</sup> The limonite is due to weathering of pyrite.

Geology Department, J. S. R. KRISHNA RAO.  
Andhra University, T. RAMAKRISHNA MURTY.  
March 15, 1963.

1. Krishna Rao, J. S. R., *Curr. Sci.*, 1963, **32**, 74.
2. Mahadevan, C., *Quart. Journ. Geol. Min. and Met. Soc. Ind.*, 1929, **2** (4), 171.
3. — and Sathapathi, N., *Ind. Geog. Journ.*, Jan.-March 1949, **24**(1), 5.
4. Murty, M. S., *D.Sc. Thesis*. (Unpublished), Andhra University, 1961.

#### PREHNITE FROM PINNAPURAM, TADAPATRI TALUK, ANANTAPUR DISTRICT (ANDHRA PRADESH)

DURING a recent visit to the Cuddapah formations in the vicinity of Rayalcheruvu, Tadapatri Taluk, an interesting mineral was collected from the basic sill due east of Pinnapuram (N. 15° 4' : E. 77° 51' 45"). The sill has intruded into the Tadapatri shales of the Lower Cuddapah System and is doleritic in composition. The metamor-

phosed rocks along with the sill occur in the form of a small hillock (1,000 contour) due east of Pinnapuram.

The mineral exhibiting bladed and radiating structure in the form of rosettes occurs as a narrow vein in the sill measuring about 2-3 inches in thickness. It has a pale green colour in bulk becoming almost colourless in thin fragments. Lustre is typically vitreous tending to become somewhat pearly on fractured surfaces. The mineral is brittle with distinct cleavage and uneven fracture. The specific gravity is 2.93.

Under the microscope the mineral appears as long blades exhibiting distinct cleavage with fine lamellar twinning very similar to that of microcline (Fig. 1). It is colourless showing high relief. The mineral under study is optically positive with typical biaxial characters, having an average optic axial angle of  $60 \pm 1^\circ$  as determined on the Universal Stage. The birefringence, determined by the Berek Compensator, is 0.032. The mineral shows straight extinction and positive elongation.



FIG. 1 Crossed nicols,  $\times 27$ .

Based on these characters the mineral has, therefore, been identified as Prehnite. The occurrence of this mineral has not been reported so far from the Cuddapah formations. Further its occurrence in the form of a small vein in the basic igneous rock as a secondary mineral suggests possibly a hydrothermal origin. Similar properties and mode of origin for the mineral have been stated by Dana (1932) and Deer *et al.* (1962).

A detailed paper incorporating the chemical and X-ray results of the mineral is under preparation.



Department of Geology, B. V. GOVINDA RAJULU,  
University of Mysore, M. N. VISWANATHIAH,  
Manasagangothri,  
Mysore-2, May 31, 1963.

1. Dana, E. S., *A Textbook of Mineralogy*, Fourth Edition, John Wiley & Sons, 1932, pp. 626.
2. Deer, W. A., Howie, R. A. and Zussman, J., *Rock Forming Minerals*, Longmans, 1962, 3, 265.

### A NOTE ON THE PALAEONTOLOGY AND STRATIGRAPHY OF THE JABALPUR SERIES

The Jabalpur Series is divided into the Jabalpur and Chaugan stages on the basis of the absence or presence of cycadophyte plants. In search of plant fossils at Para Simla Hills, Jabalpur, the writer has collected the following plant fossils which have not been reported from Jabalpur Town, the type area of Jabalpur Stage.

- Pteridophyta: *Alethopteris whitbyensis* (Bgt.), *Tarchopteris vittata* (Bgt.).  
Cycadophyta: *Ptilophyllum acutifolium* (Morris), *P. Distance* (Femt.), *P. Cutchensis* (Morris), *P. Jabalpurensis* (Jacob), *Nilssonia Princeps* (O & M), *Nilssonia spec.*  
Coniferales: *Elaeocladus conferta* (O & M), *F. indica* (Codd.), *Pityophyllum* Sp. nova (Nathrad.), *Doximophyllum lanceolatus* (Femt.).

The author has also collected some conifer stem impressions and one probably of *Euriphyllum* (Femt.). Crookshank, while classifying the Jabalpur Series into two stages, felt the artificiality of his classification and stated "the rocks of Chaugan and Jabalpur Stages are lithologically very similar and I regard their division on palaeontological grounds as rather artificial. I think it very probable that the order Rajmahal Plants will ultimately be found in the vicinity of Jabalpur also in which case there will be no longer any reason for splitting the Jabalpur Series into two artificial stages" (p. 250).

In the light of these new fossils collected from the Jabalpur area (which includes seven cycadophytes), it is proposed to drop the division of Jabalpur Series into two stages. The Jabalpur Series may be taken as intermediate between Rajmahal and Ummia Series, as it contains a mixture of flora of both these series. The exact relation of this series with the Rajmahal or Ummia Series cannot be established as rocks equivalent to the Jabalpur Series are not developed in the Rajmahal or Ummia Areas.

Department of Geology, A. P. AGRAWAL,  
Government Science College,  
Jabalpur, March 21, 1963.

1. Crookshank, H., *Geology of Northern Slopes of Satpura, G.S.I. Mem.* 66, Part 2, 1936.
2. Jacob, K. and Jacob, C., *Pal. Indica*, 1954, New Ser. Vol. 33, Mem. No. 1.
3. Pascoe, E., *A Manual of Geology of India and Burma*, 1959, 2.
4. Seward, A. C., *Fossil Plants 1898-1919*, 1-4.

### COMPARISON OF THE EFFECTS OF ANDROGENIC HORMONE AND TESTOSTERONE PROPIONATE ON THE FEMALE OCYPOD CRAB

It is well known that the androgenic gland, which is present in the males of Malacostraca, has a masculinising function. This gland and its function were first discovered by Charniaux-Cotton<sup>1,2</sup> in *Orchestia gammarellus*. The present author has described the androgenic gland in fourteen Indian species of crustacea and has also shown its masculinising effect when transplanted into the female of *Ocypoda platytarsis*.

The chemical nature and mode of action of the androgenic hormone have been under investigation in our laboratory. The present note compares the effect of the androgenic hormone and testosterone on the female crab.

Four female specimens of *O. platytarsis*, measuring about 30 mm. in width of carapace, were injected with testosterone propionate, and three specimens of similar size were injected with an extract of androgenic gland. The details of experimental procedures were similar to those already described by the author.<sup>3,4</sup> The specimens were under observation for a month. During this period the experimental animals were given five injections of testosterone propionate in doses of 4 to 5 mg. A rather large dose was used in order to overcome any antagonistic hormones which might be present in the female specimens. Of the experimental animals, two survived, and of the control animals three survived.

The specimens which were injected with the extract of androgenic gland developed male secondary sexual characters. The abdomen became relatively narrow, and the length increased from 10 mm. to 14 mm. and the appendages characteristic of the male developed. Internally, it was found that the ovary had transformed into testis with spermatagonia and spermatocytes. In the specimens injected with testosterone, the female secondary sex characters persisted, but internally the ovary was found to have transformed into the testis.

Thus the androgenic gland is able to transform the ovary as well as the secondary sex characters, but the vertebrate male hormone acts only on the ovary but not on the secondary sex characters of the crab.

My thanks are due to Prof. R. V. Seshaiya for suggesting the problem and to the University Grants Commission for the award of a scholarship.

Marine Biological Station,  
Porto Novo, June 15, 1933.

S. SAROJINI.

1. Charniaux-Cotton, H., *Compt. rend.*, 1954, **239**, 780.
2. —, *Ibid.*, 1955, **240**, 1487.
3. Sarojini S., *J. zool. Soc. India*, 1961, **13**, 188.
4. —, *Ibid.*, 1962, **14**, 141.

### SEASONAL VARIATIONS IN THE CUTICLE OF MYRIAPODA

FUHRMAN<sup>1</sup> AND LANGNER<sup>2</sup> reported in the chilopods and diplopods studied by them, an outermost hyaline layer of the cuticle which they considered as epicuticle. Cloudsley-Thompson<sup>3</sup> reported in *Lithobius* and *Geophilus* an epicuticle which he distinguished from the rest of the cuticle by its differential solubility in chlorated nitric acid. Krishnan<sup>4</sup> reported in *Scolopendra subspinipes* a similar layer which has been shown to correspond to the epicuticle of insects in its structural and general chemical features in containing an inner lipo-protein layer overlaid by a lipoidal layer. But Blower<sup>5</sup> from his studies on the cuticle of *Lithobius*, *Schizophyllum* and other myriapods emphasized the absence of a chitin-free outer layer comparable to the epicuticle of insects. He, however, ignored an outermost hyaline layer in the preparations studied by him considering it as a diffraction effect. It will be seen that existence of an epicuticle in Myriapoda is still a subject of controversy. The following is an account of a feature with reference to the cuticle of *Cingalobolus bugnioni*, a diplopod, noted in the course of ecological studies on Myriapoda which has a bearing on the question on the existence of an epicuticle in this group.

In the cuticle of *Cingalobolus bugnioni* there is an outermost layer bearing spines staining red with Mallory. This layer does not survive in chitosan preparations and resists the action of concentrated mineral acids. In hardened cuticle this layer is yellow-coloured. Both chemically and histologically it is distinguished from the procuticle, and corresponds to the epicuticle

described in other arthropod cuticles (Fig. 1). In an ecological study of the cuticle of this species, extending over a year, specimens were collected in the neighbourhood of Madurai, at regular intervals. During the dry season (January to August) these millipedes show the presence of an epicuticle as described above. They are found to bury into the soil and remain inactive. With the onset of the rainy season they come out of the soil to the surface and are more active. Immediately after their emergence they undergo a moult. The specimens examined after the moult show that the layer corresponding to the epicuticle, noted in animals in dry season, is absent. This feature has been noted in all the specimens examined periodically during the winter season (September to December). In winter an epicuticle is wanting and in summer there is a well-defined layer answering to the description of an epicuticle external to the procuticle.

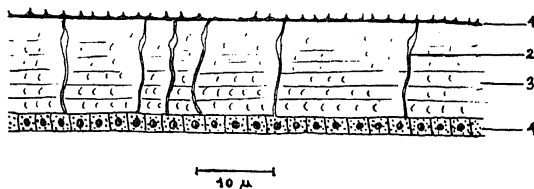


FIG. 1. Transverse section through the cuticle of *Cingalobolus bugnioni* stained by Mallory method. (1) Epicuticle, (2) Gland Dact, (3) Procuticle, (4) Epidermis.

With a view to find out the significance of the feature reported above a study of the water loss through the cuticle in the millipedes with an epicuticle and those without one has been studied. It is seen that the water-loss is greater in the absence of an epicuticle and is markedly less when an epicuticle is present (Fig. 2).

It may be recalled in this connection that the transpiration curves for the diplopods *Paradesmus*<sup>6</sup> and *Glomeris*<sup>7</sup> are not similar. The curve obtained for *Glomeris* rises very steep, indicative of loss of large amount of water through the cuticle while that obtained for *Paradesmus* rises gradually indicative of loss of small amount of water through the cuticle. This difference in the rate of transpiration has not been accounted for by previous workers. It would be seen from Fig. 2 that the transpiration curve obtained for *Cingalobolus* with epicuticle is closely similar to that obtained for the millipede *Paradesmus*, and that obtained for *Cingalobolus* without epicuticle is closely similar to that obtained for the millipede *Glomeris*. It is suggestive that the specimen used by

Cloudsley-Thompson<sup>6</sup> may not be identical in its cuticular organization with that used by Edney.<sup>7</sup> In the light of the present observations it is suggested that the diplopods used by Edney may be those without an epicuticle and correspondingly the water loss through the cuticle is more.

So far there is no report of a seasonal variation in the structure and function of the cuticle of myriapods. The above observations may explain the non-unanimity on the occurrence of an epicuticle in Myriapoda.

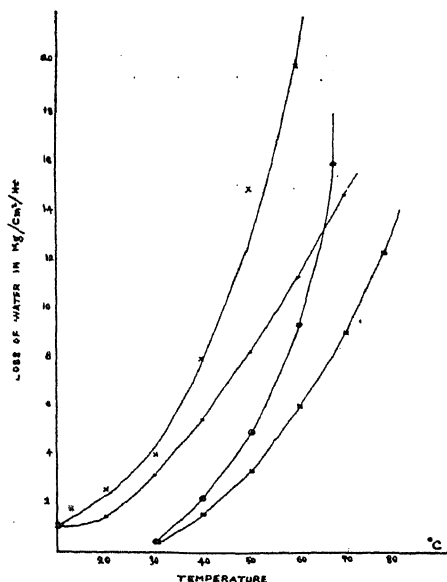


FIG. 2. Rate of water loss at various temperatures from *Cingalobolus*.

- × — × *Glomeris*
- — ● *Paradesmus*
- — ○ *Cingalobolus*—without epicuticle
- ◆ — ◆ *Cingalobolus*—with epicuticle

I wish to thank Professor G. Krishnan for his valuable guidance and encouragement during the course of this work. I gratefully acknowledge the receipt of a Madras University Studentship.

Department of Zoology, G. SUNDARARAJULU.\*  
Madras Univ. Extension Centre,  
Madurai-2, March 20, 1963.

\* Present address : University Zoological Laboratory, Madras-5.

1. Fuhrman, H., *Zeitscher. f. wiss. Zool.*, 1921, **119**, 1.
2. Langner, E., *Zool. Jahrb Anat.*, 1937, **63**, 483.
3. Cloudsley-Thompson, J. I., *Nature* (London), 1950, **165**, 692.
4. Krishnan, G., *Physiol. Zool.*, 1956, **29**, 324.
5. Blower, J. G., *Quart. J. micr. Sci.*, 1951, **92**, 141.
6. Cloudsley-Thompson, J. I., *Ibid.*, 1950b, **91**, 453.
7. Edney, E. B., *J. Expt. Biol.*, 1951a, **28**, 91.

# ON A NEW RECORD OF A BLENNIID FISH, *PETROSCIRTES KOCHI* M. WEBER, FROM ANDAMANS

WHILE working on the shore-fish fauna of Andamans, I came across a specimen of *Petroscirtes kochi* M. Weber, obtained from muddy shore near the Phoenix Bay, Port Blair, Andamans. *Petroscirtes kochi* Weber is easily distinguished by the presence of about 9 cross-bars on the sides, below the dorsal, which originates slightly before gill-opening; lateral-line high up, ending below the 10th dorsal ray, and a dark blotch on nape. This species has not been recorded so far from Indian waters. Day (1878) described six species of the genus *Petroscirtes* Ruppell from India, of which only *Petroscirtes variabilis* Cantor was reported from Nicobars. Herre (1939, 1941) recorded four more species of the genus from Andamans. Thus so far only five species of *Petroscirtes* are known from Andaman waters.

*Petroscirtes kochi* Weber is known so far from brackish waters of New Guinea and Siam (Beaufort and Chapman, 1951). The present find indicates a wider range of distribution, extending from New Guinea, Siam to Andamans—the western outpost of the East Indies from the standpoint of distribution of fishes. From this greater range of distribution than was known before it is likely that this species might occur in adjacent islands also.

Zoological Survey of India, G. M. YAZDANI.  
Calcutta, March 27, 1963.

1. Day, F., *Fish India*, 1878, p. 325.
2. Herre, A. W. C. T., *Rec. Indian Mus.*, 1939, **41**, 355.
3. —, *Mem. Indian Mus.*, 1941, **13**, 393.
4. Beaufort, L. F. De and Chapman, W. M., *Fish Indo-Austral. Archipel.*, 1951, **9**, 376.

## A NOTE ON THE OCCURRENCE OF THE DEEP WATER TELEOST *ATELEOPUS* (ORDER INIOMI) OFF THE COAST OF KERALA

DURING the offshore cruises of the Research Vessel 'CONCH' of the University of Kerala, collections were made of bottom fishes below the continental shelf. Among the collections thus made, two specimens of the rare teleost *Ateleopus* were obtained, one belonging to the species *Ateleopus indicus* Wood Mason and Alcock and the other to the species *Ateleopus natalensis* Regan. Details regarding the stations and the gear used for collection are given in Table I.

TABLE I

Name of species	Station Number	Location	Nature of bottom	Depth in fathoms	Gear used	Date of collection
<i>Ateleopus indicus</i> ..	222	75° 55' 30" E. 09° 05' 00" N. off Quilon	Fine grey sand with minute shell fragments	180	Beam Trawl	11-3-1960
<i>Ateleopus natalensis</i>	208	75° 35' 30" E. 09° 50' 00" N. off Cochin	Fine black sand and mud with minute shell fragments	125	Beam Trawl	2-3-1960

The genus *Ateleopus* includes three species. *A. japonicus* Schleg. is known from the seas around Japan; *A. indicus* from the seas around Philippines, Maldives, Andamans, Nicobars and the Western coast of South India and *A. natalensis* from the western and eastern sides of the Arabian Sea, all from deep waters below the continental shelf.

A single specimen of *A. indicus* measuring 30 cm. was first collected from the Bay of Bengal from around Andaman and Nicobar Islands by Alcock during the cruises of 'Investigator' (1890-91). Later, *John Murray Expedition* (1933-34) collected four specimens varying in length from 26 cm. to 37 cm. Of these, two specimens measuring 26 cm. and 37 cm. were from the Maldiva area and one was from the sea around Philippines and the fourth from the Arabian Sea (8° 37' N. and 75° 37' E.). This station is very close to the Station No. 222 of R.V. 'Conch', from where the present specimen was collected. The present specimen measuring 18 cm. is smaller than the five already recorded.

*A. natalensis* is also a rare species. Norman collected two specimens measuring 48 cm. and 54 cm. in length during the cruises of 'Mabahiss' from the Zanzibar area, off the Natal coast from depths of 640 to 658 m. The present specimen is 24.4 cm. in length.

Both the above species are associated with bottom sediments consisting of fine black or grey sand mixed with shell fragments. The black or grey colour of the body is matched by the colour of the bottom deposit. The specimens of *A. indicus* and *A. natalensis* agree with previous descriptions in details of morphology and colour. But the present record of the occurrence of *A. natalensis* off the coast of Kerala extends the known distribution of this species to the west coast of India.

University of Kerala

C. T. SAMUEL.

Oceanographic Laboratory,  
Ernakulam, March 22, 1963.

1. Wood Mason, J. and Alcock, *Ann. Mag. Nat. Hist.*, 1891, 8(6), 123. Fig. 3.
2. Norman, J. R., *John Murray Expedition*, 1939, 7, 32.
3. Regan, Tate, C., *Ann. Mag. Nat. Hist.*, 1921, 7(9), 412.

**CRICONEMA SERRATUM N. SP.**  
(NEMATODA: CRICONEMATIDAE),  
A PARASITE OF PEACH TREES  
IN ALMORA, NORTH INDIA

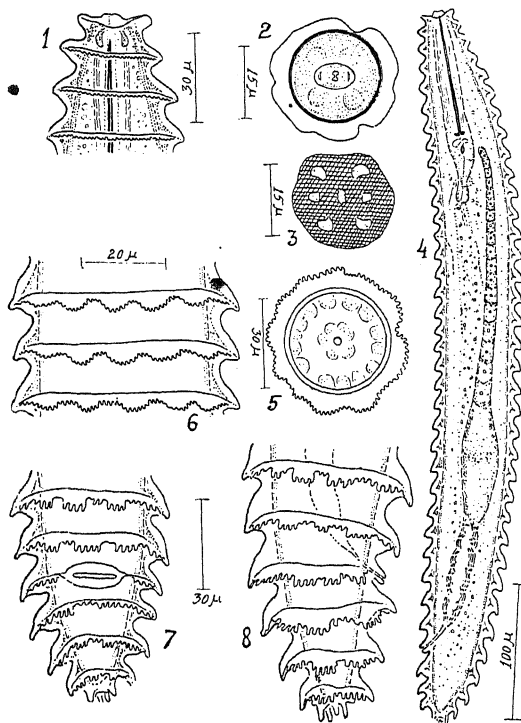
ON the advice of Dr. Boshi Sen, Director of the Vivekananda Botanical Research Laboratory, Almora (U.P.), one of us (E.K.) examined some diseased peach trees growing in the campus of V.B.R.L., Almora. Examination of the soil and root samples of such trees revealed the presence of a *Criconema* sp. in sufficiently large numbers to cause disorders. The general symptoms of the disease were retarded growth, wilting of the leaves and general dieback effects. The nematode on examination was found to be a new species for which the name *Criconema serratum* n. sp., is proposed. The specific epithet refers to the serrated margins of the annules. A description of the worm follows.

*Measurements*.—10 ♀♀: Length = 0.5–0.6 mm.;  $a = 10-11$ ;  $b = 3.1-3.5$ ;  $c = ?$ ;  $V = 90-94\%$ ; spear = 90–96 microns. Holotype ♀: Length = 0.5 mm.;  $a = 10$ ;  $b = 3.3$ ;  $c = ?$ ;  $V = 90\%$ ; spear = 90 microns.

*Criconema serratum* N. SP.  
(Figs. 1-8)

*Description*.—Body with 36–38 annules covered with abnormally thick cuticle. Body annules retrorse, with a continuous fringe of reduced spines which give a serrated appearance. These spines are well-developed in the hinder part of the body (Figs. 7 and 8). The posterior margins of annules bear lobe-like outgrowths which number 12 near mid-body (Fig. 6). Head with two annules, the anterior one directed outward and forward, *En face* view showing

an oval labial disc bearing the apertures of mouth and amphids. The oral aperture is guarded by two liplets which are lateral in position. Four sub-lateral lobes present around the labial disc (Fig. 2). Cephalic skeleton sclerotized, hexaradiate (Fig. 3). Spear strongly developed, with anteriorly cupped basal knobs. Oesophagus typically criconemoid (Fig. 4). Excretory pore on 12th to 14th annule from anterior end. Vulva a transverse slit, located on 4th to 5th body annule from posterior end (Figs. 4, 7 and 8).



FIGS. 1-8. *Criconema serratum* n. sp. Fig. 1. Cephalic end of female. Fig. 2. En face view of female head. Fig. 3. Cross-section of head through basal plate. Fig. 4. Female, lateral. Fig. 5. Cross-section of body through fifth annule showing cuticular ornamentation. Fig. 6. Cuticular ornamentation of annules near mid-body. Fig. 7. Caudal end of female, ventral. Fig. 8. Caudal end of female, lateral.

Ovary well-developed, with oocytes arranged in a single row. Anus not located. Caudal extremity rounded. Male not found.

**Type material.**—Holotype female collected on 3rd May, 1963 in slide No. PN/C/2-005, deposited with the Zoology Museum, Aligarh Muslim University, Aligarh (U.P.), India. Paratypes in the possession of authors.

**Type host and locality.**—Peach tree, *Prunus persica* (L.) Batsch, growing in the campus of V.B.R.L., Almora (U.P.), India.

**Differential diagnosis.**—*Criconema serratum* n. sp. is distinguished from all the known species of *Criconema* by having the smallest number of body annules and the characteristic cuticular ornamentation of the body annules. This species comes close to *C. brevicaudatum* Siddiqi, 1961, from which it differs in having a longer spear (spear  $58\mu$  long in *C. brevicaudatum*) and lesser number of body annules.

Sec. of Plant Nematology, EKRAMULLAH KHAN.  
Department of Zoology, M. RAFIQ SIDDIQI.  
Aligarh Muslim University,  
Aligarh (U.P.), India, June 13, 1963.

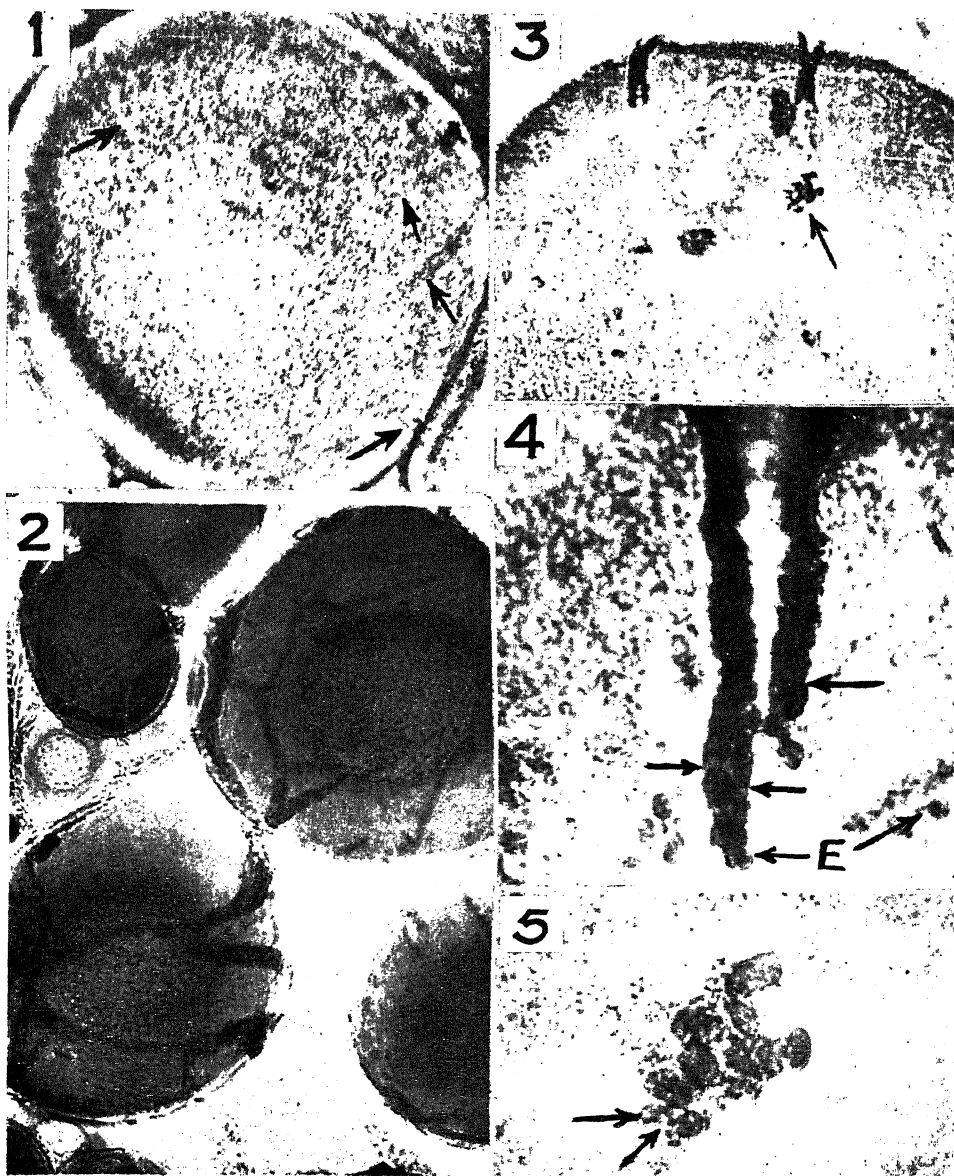
1. Siddiqi, M. R., *Proc. helm. Soc. Wash.*, 1961, 28 (1), 19.

#### ON THE NATURE OF NOURISHMENT OF THE GROWING OOCYTES OF THE FROG AND ITS BEARING ON THEIR DNA-CONTENT

IN recent years, studies on the biochemical composition of yolky eggs of insects, amphibians and birds have produced evidence to show the presence of the DNA-reserve and its various degradation products in the cytoplasm of unfertilized eggs of these animals (Brachet, 1957). It has been shown that the unfertilized egg of the frog and of the hen contains enough DNA to produce about 5,000 cells and about  $5 \times 10^7$  cells respectively, and fresh DNA synthesis begins in both cases, at a considerably later stage of development (Hoff-Jørgensen and Zeuthen, 1952; Hoff-Jørgensen, 1954; Solomon, 1957).

It has been shown, in the case of insects, that the nucleated nurse cells make direct or indirect contribution to the cytoplasm of the growing oocytes (Brachet, 1957; Briggs and King, 1959). As the nuclei of the nurse cells contain DNA, there is no difficulty in accounting for the presence of DNA and its breakdown products in the insect oöplasm.

In the case of vertebrate eggs (e.g., amphibians and birds), the precise mode of transfer or the nature of material transported within the oocytes is not known. The present author has observed certain new facts concerning the mode and nature of nourishment of the growing oocytes of *Rana tigrina*, which have bearing in this context. A brief account of the findings is reported here.



FIGS. 1-5. Fig. 1. A living oocyte with dark carmine stain and tubules marked with arrows. After injection of ammoniacal carmine solution,  $\times 100$ . Fig. 2. A group of oocytes showing the arrangement of the blood vessels,  $\times 100$ . Fig. 3. A part of a large oocyte showing tubular channels. A clump marked with arrow is shown in Fig. 5,  $\times 100$ . Fig. 4. Two tubular channels in a part of the ooplasm. Note their membranous wall marked with arrows and erythrocytes, E,  $\times 450$ . Fig. 5. A clump of erythrocytes, shown in Fig. 3. Note the dark nuclei,  $\times 450$ .

The living oocytes and their sections, at all stages of growth, were examined with phase-contrast and ordinary microscopes during the last three years. Examination of teased pieces of living ovary seemed to indicate a close relationship between many oocytes and the

surrounding blood vessels, from which erythrocytes appeared to enter the immature oocytes.

To test this observation experimentally, diluted ammoniacal carmine solution was injected in female frogs through the dorsal aorta, the ovary was taken out after some time, and its

pieces were teased on clean slides in the physiological saline. The eggs were gently flattened by covering them with a clean cover glass. Some such preparations were sealed with paraffin and examined immediately and others were fixed by irrigation of Bouin's fluid through the cover glass with the help of a piece of blotting paper. The fixed preparations were stained with dilute Leishmann's stain, differentiated in 70% alcohol, dehydrated, cleared in xylol and mounted in balsam. Examination of the intravitaly stained preparations revealed that carmine stain entered the immature oöcytes from the blood vessels through fine tubules (Fig. 1). In the fixed preparations, the blood vessels and capillaries along with the erythrocytes in red colour stood out against a blue or bluish background of the egg cytoplasm (Fig. 2). These two experiments bore out the previous observation and went even a step further in showing that material may pass directly from the blood stream into the oöcytes.

Pieces of ovary were also fixed in 2% osmium tetroxide solution for 6 hours and then transferred into buffered 10% neutral formalin solution for 12 hours. After washing for 12 hours, they were embedded in paraffin and sectioned 2 to 3  $\mu$  thick. When such sections were examined after de-paraffinization with xylol, delicate cytoplasmic channels were seen to run from the cell membrane into the interior part of the eggs (Figs. 3 and 4). Each channel is tubular in outline and, in some cases, these channels contained erythrocytes (Figs. 4 and 5). When these red cells were compared with the "Yolk platelets" of an unsegmented ovum of the frog at the same magnification, the resemblance in shape and size was apparent. Such a channel, when traced up to the cell periphery, was seen to be in direct connection with a blood vessel. There is also histochemical evidence to show the presence of hæmoglobin and its various breakdown products in the oöplasm (Chatterjee, 1963).

In view of the above evidence, it seems clear that the erythrocytes along with plasma enter the growing oöcytes of the frog. The fact, that the erythrocytes in the egg cytoplasm and the "Yolk platelets" of a mature ovum look alike, becomes significant in the light of these observations. As the red cells of the amphibian blood are nucleated, each of them contributes its DNA-content along with its protoplasm to the egg cytoplasm when undergoing disintegration within the oöcyte. It may therefore be inferred that the erythrocytes, by disintegration,

become the source of additional supply of DNA material to the maturing amphibian oöcytes.

The author is indebted to the authorities of Patna University for financial assistance, to Prof. S. Keshava for his encouragement and all kinds of help, and to Mr. J. N. Verma for helping in preparation of the illustration.

Post-Graduate Dept. of NIRMALA CHATTERJEE.  
Zoology, Patna University,  
Patna-5, February 25, 1963.

1. Brachet, J., *Biochemical Cytology*, Academic Press, 1957.
2. Briggs, R. and King, T. J., In *The Cell*, Edited by Brachet, J. and Mirsky, A. E., Academic Press, 1959, 1.
3. Chatterjee, N., 1963 (In press).
4. Hoff-Jørgensen, E. and Zeuthen, E., *Nature*, 1952, 169, 245.
5. —, *Colden Papers*, 1954, 7, 79.
6. Solomon, B., *Bioche. et Biophys. Acta*, 1957, 23, 211.

#### ROLE OF BLUE GREEN ALGAE ON PADDY YIELD

The beneficial role of certain blue-green algæ in fixing atmospheric nitrogen under waterlogged conditions is now well established.<sup>1-7</sup> The actual fixation may be brought about by blue-green algæ alone or in association with bacteria such as *Azotobacter*, *Clostridium*, etc. Other forms of algæ may indirectly participate and improve the fertility of rice fields by supplying organic matter and preventing loss of soil nitrogen by leaching and denitrification. Thus from agronomical point of view, inoculation of blue green algæ even as mixtures of species or strengthening of the existing nitrogen-fixing forms with suitable chemical nutrients is likely to build up the fertility of paddy soils.

*Experimental.*—Two experiments were conducted, one in pots and the other under large-scale field conditions with five and four replications respectively in the second crop season (November-April, 1961-62) using an early maturing variety *Ptb. 10*. There were 18 treatments, A to R, as indicated below:—

A—Ammonium Sulphate at 16.8 Kg. N/hectare:  $J = A + \text{Algæ}$ .

B—Ammonium Sulphate at 33.6 Kg. N/ha.:  $K = B + \text{Algæ}$ .

C—Superphosphate at 67.2 Kg.  $P_2O_5$ /ha.:  $L = C + \text{Algæ}$ .

D—Superphosphate as above + sodium molybdate at 0.28 Kg./ha. (trace):  $M = D + \text{Algæ}$ .

E—Lime at 2242 Kg./ha.:  $N = E + \text{Algæ}$ .

F—Lime + sodium molybdate at above rates:  $O = F + \text{Algæ}$ .

G—Superphosphate + lime + sodium molybdate at above rates: P - G + Algæ.

H—Sodium molybdate at above rates: Q - H + Algæ.

I—Control (No manure): R - I + Algæ.

Blue green slimy formations on the surface of soil consisting of *Nostoc*, *Anabæna*, *Microcystis*, *Phormidium* and *Aphanothece* (blue-green algæ) were scraped, air-dried and inoculated at the rate of 3.0 gm. per 15 Kg. of soil per pot and 340.0 gm. per plot (1/187.06 hectare). The crop in the field suffered from an attack of stem borers which adversely affected the yield. Yields of grain and straw are given in Table I.

TABLE I

Yields of paddy, grain and straw

Treatment	Pots (gm. per pot) average of five replications		Treatment	Field Kg. per hectare. Average of four replications	
	Grain	Straw		Grain	Straw
1	2	3	4	5	6
K	26.42*	23.54	K	564.24*	1595.81
B	26.36*	28.04	B	503.22*	1710.59
N	19.14*	18.70	P	512.67*	1672.40
P	19.10*	16.74	G	474.88*	1557.41
A	18.06*	16.14	J	403.52	983.06
O	16.34*	15.40	A	409.01	1148.91
G	16.18*	15.44	M	387.56	1021.25
J	16.08*	13.41	O	385.01	1353.10
C	14.56	11.24	N	379.91	957.52
L	13.92	11.10	C	377.86	1097.84
D	13.22	10.44	D	375.31	1034.12
F	13.10	10.90	L	371.74	1199.97
M	12.88	10.68	R	347.74	1238.37
E	12.22	10.00	Q	335.99	1136.24
R	12.22	10.48	E	332.93	983.06
Q	11.70	9.20	F	330.89	1021.25
H	11.38	9.36	H	317.10	880.93
I	10.56	9.54	I	291.57	1085.18
S.Em.	±1.60	±1.37		±56.64	±150.53
C.D. at 5%	4.51	3.85		160.74	427.22

\* Significantly better than control.

**Pot Experiment.**—There was such an excessive growth of green algal forms (*Spirogyra* sp. and *Euglena* sp.) in the ammonium sulphate treatments that frequent stirring of the top soil had to be done to prevent smothering of the plants. It is clear from Table I that blue-green algæ could be an effective substitute for ammoniacal nitrogen. Blue-green algal forms are known to prefer a slightly alkaline medium for optimal activity which may be the reason for a higher response in the presence of lime.

**Field Experiment.**—Certain precautionary measures were taken in the lay-out and conduct of the field experiment. The irrigation water,

obtained from a tube-well about 320 feet deep was led through a cement channel. It was first allowed to run into a near-by rice field to make it almost free from algal forms growing in the cement channel and then brought into the main channel of the experimental area. From here, it was taken into adjoining parallel channels and slowly delivered into individual plots. The plots were all separated from one another by wide and deep channels to drain away any water in case of leakage through a field bund. The bunds themselves were constantly pressed, strengthened and reinforced. Weeding, interculturing, recording of observations and harvesting of crops were all carried out first in non-algal plots to prevent contamination into them from algal-inoculated plots.

The results of field experiments are more or less in line with results of the pot experiments although only four treatments give a significantly higher yield.

The author thanks Dr. R. H. Richharia, Director, for encouragement, Dr. R. Subrahmanyam, for identifying the algal forms and going through the manuscript and Dr. M. N. Sahay, for supplying algæ.

Division of Blue Green Algæ, L. L. RELWANI,  
Central Rice Research Institute,  
Cuttack-4, April 4, 1963.

1. De, P. K., *Proc. Roy. Soc. (London)*, 1939, 127 B, 121.
2. Fogg, G. E., *J. Bot.*, 1951, 2, 117.
3. Jha, K. K., *Proc. Rice Research Workers Conference, Cuttack, I.C.A.R., New Delhi*, 1959, p. 266.
4. Singh, R. N., *Indian J. agric. Sci.*, 1942, 12, 743.
5. —, *Role of Blue-Green Algae in Nitrogen Economy of Indian Agriculture*, I.C.A.R., New Delhi, 1961.
6. Venkataraman, G. S., Datta, N. and Natarajan, K. V., *J. Indian bot. Soc.*, 1959, 38, 114.
7. Watanabe, A., Nishigaki, S. and Konishi, C., *Nature*, 1951, 168, 748.

## STRONTIUM IN SOME INDIAN VEGETABLES

THE lack of information on the strontium content of Indian plant materials, particularly the leafy vegetables, and the absence of any simple micro-chemical method for its determination have prompted us to undertake this study. Full details of the procedure will be published elsewhere. The method is essentially a combination of paper partition chromatography for separating strontium from calcium and barium using the solvent system— $\text{CH}_3\text{OH}:\text{HCl}:\text{H}_2\text{O}$  (80:10:10)<sup>1-3</sup> and subsequent measurement of colour density of strontium complex with



o-cresolphthalein complexone.<sup>4</sup> It will be seen from the data in Table I that per gramme of

TABLE I

Strontium content of different vegetables

Samples *	Dry matter (%)	Ca/gm. dry matter (μg.)	Sr/gm. dry matter (μg.)	Ca/Sr
Radish leaves ( <i>Raphanus sativus</i> )	7.08	26526	856.7	30.9
Radish leaves ( <i>Raphanus sativus</i> )	7.08	26526	801.1	33.1
Mustard leaves ( <i>Brassica napus</i> )	8.06	16274	96.3	169.0
Spinach ( <i>Spinacia oleracea</i> )	6.26	11770	77.6	151.6
Coriander leaves ( <i>Coriandrum sativum</i> )	11.97	10964	69.8	157.1
Methi leaves ( <i>Trigonella foenugracum</i> )	13.02	14470	54.5	265.5
Lettuce ( <i>Brassica oleracea</i> )	8.52	13014	40.0	325.2
Cabbage ( <i>Brassica oleracea capitata</i> )	7.67	5257	33.2	158.3
Mixed lawn grass ( <i>Hordeum vulgare</i> )	10.69	5220	25.1	208.0

\* The leafy portion with a small part of the stalk was mainly taken for sampling.

dry matter, strontium content lies within 100 μg. except in radish leaves where it is more than 800 μg. Such differences presumably depend on the species of the plant and the type of soil, and the Ca/Sr ratio might indicate the relative uptake of these two elements from the soil. None of the studies reported in the literature<sup>5-11</sup> included any of the plants analysed here except grass and spinach. The lowest strontium value of 25.1 μg. for grass and 77.6 μg. for spinach are quite comparable to the foreign data.<sup>5,11</sup> Barium was appreciably perceptible in only some of the samples and lead was detected in the chromatogram in the case of Methi leaves only. The simplicity of the technique and the reproducibility of results points to its usefulness in the analysis of plant materials.

Defence Science Laboratory, B. C. RAY SARKAR.  
Delhi, April 1, 1963. U. P. S. CHAUDHAN.

1. Sommer, G., *Z. Anal. Chem.*, 1956, **151**, 336.
2. Blasius, E. and Gottling, W., *Ibid.*, 1958, **162**, 423.
3. Dasing, W. and Kunze, H., *Ibid.*, 1958, **162**, 345.
4. Pollard, F. H. and Martin, J. V., *Analyst*, 1956, **81**, 348.
5. Bowen, H. J. M. and Dymond, J. A., *Proc. Roy. Soc.*, 1955, **144 B**, 355.
6. Headden, W. P., *Bull. Cal. Agric. Exp. Sta.*, 1921, 267.

7. Robinson, W. O., Steinkoenig, L. A. and Miller, C. F., *Bull. U.S. Dept. Agric.*, 1917, No. 600.
8. Mitchell, R. L., *Research*, 1948, **1**, 159.
9. —, *Tech. Commun. Bur. Soil Sci. Herpenden*, 1948, No. 44.
10. Collander, R., *Plant Physiol.*, 1941, **16**, 691.
11. Albrecht, W. A. and Schroeder, R. A., *Soil Sci.*, 1942, **53**, 313.

### TETRAMERY IN *TULIPA STELLATA* HOOK.

*Tulipa stellata* Hook. (Liliaceae) is a wild species of *Tulipa* found growing in the Himalayas from 3,000 to 10,000 feet above sea-level. Its distribution ranges from Simla hills to Kangra, Kulu and Kashmir Valleys. This species is characterised by trimerous condition of its flower (Collett).<sup>1</sup> In the large collection of tulips maintained at the Vegetable Breeding Sub-station, Katrain (Kulu Valley), the trimerous condition has been found to be a constant character. During the last season, however, a few plants having complete tetramerous flowers and some intermediate types between trimerous and tetramerous conditions were observed amongst the collection.

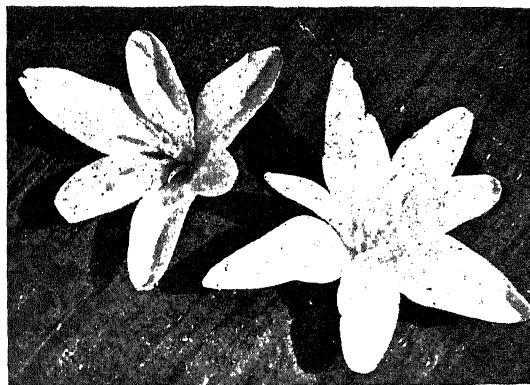


FIG. 1. Showing increased size of tetramerous flower right as compared to the normal trimerous on the left side.

This case of tetramery is interesting both from the point of view of taxonomy and floriculture. The increased number of outer and inner perianth segments makes the flower bigger in size over the ordinary variety (Fig. 1). The tetramerous flowers have eight perianth segments and eight stamens, both in two whorls of four each, with tetracarpellary ovary and four stigmatic lobes while in the usual trimerous flowers the perianth segments and stamens are six in number, both arranged in two whorls (3 + 3) and the ovary is tricarpellary with three stigmatic lobes.

Besides the complete tetramerous condition a few intermediate forms between the tetra- and tri-merous conditions were also observed. This indicates that the tetramerous condition has not arisen directly but gradually through some transitional stages. All the plants having normal flowers were completely pollen-fertile. However, the anthers in the tetramerous flowers were found to dehisce later than those of the normal flowers.

Our thanks are due to Dr. B. P. Pal and Dr. S. K. Mukherjee for encouragement during the course of these studies.

Indian Agric. Res. Inst., VISHNU SWARUP.  
New Delhi-12, Division of J. N. SHARMA.  
Horticulture, D. P. SINGH.  
Vegetable Breeding  
Sub-station,

Katraian (Kulu Valley), February 18, 1963.

1. Collett, Sir Henry, *Flora Simlensis*, Thacker, Spink & Co., Calcutta, 1921.

### BASAL ROT OF ONION

DURING Rabi 1960, a disease in onion characterised initially by yellowing of leaves from the tips downwards partly or wholly, which later shrivelled with or without necrosis, was noticed in a severe form in the fields around Kota, Rajasthan. Affected plants could be easily pulled out of the soil, had retarded root-system, and in the bulbs (wet or dry) rotting was visible beginning from the base of the outer scales and progressively advancing towards tips and interior. In plants having complete collapse of the leaves, the entire bulb had rotted while in others the outer scales of the bulbs only exhibited rotting, which continued during storage.

Isolation from the affected bulbs gave a white fluffy mycelium with sickle-shaped, septate macroconidia, ovoid microconidia and chlamydospores identifying the fungus under the genus *Fusarium*. The culture was purified by single spore technique and morphological characters studied on 2% potato dextrose agar. Microconidia are in majority, single-celled, hyaline, ovoid to ellipsoid or curved and measure  $14.4-3.6 \times 3.6-1.8 \mu$ ; straight to sickle-shaped, hyaline, macroconidia are up to 3-septate and measure  $14.4-2.7 \times 5.4-3.6 \mu$  (1-septate),  $21.6 \times 5.4 \mu$  (2-septate), and  $23.4-37.8 \times 5.4-3.6 \mu$  (3-septate) and terminal and intercalary chlamydospores measuring  $5.4-8.2 \mu$  in diameter.

Pathogenicity experiments were carried out

with pure culture of the fungus by soil inoculation technique on two varieties (white and red skinned) of onions. Seeds as well as bulbs were sown in pots containing inoculated soil. Typical symptoms appeared within 20 days of inoculation in 38% of plants only, where the culture was added without injury to the bulbs and almost in all the plants, where the culture was added after injury to the bulbs with sterile needle. The plants in the control pots remained healthy. No symptoms, however, developed even after four months of inoculation in plants grown by seeds. These results indicate that the pathogen is a weak parasite and invades only when some injury is caused to the bulbs. Since onion is sown as a transplanted crop, it is probably during transplanting that the roots are injured and the pathogen finds its way.

The fungus failed to infect *Allium sativum* L., *Lens esculenta* Meonch E. Medit., *Linum usitatissimum* L., *Cicer arietinum* L., *Dacus carota* L., *Pisum sativum* L., *Coriandrum sativum* L., *Cuminum cyminum* L., *Foeniculum vulgare* Mill.

On the basis of the morphological characters and host range studies the pathogen is identified to be *Fusarium oxysporum* f. *cepae*.

Although basal rot of onion has been attributed to *Fusarium* species by earlier workers, only recently, *Fusarium oxysporum* f. *cepae* has been reported<sup>1</sup> to be the cause of a similar disease from Arizona. The present paper describes the disease for the first time from India.

Our thanks are due to Shri R. L. Mathur, Plant Pathologist, Rajasthan, Udaipur, for guidance.

Plant Pathology Laboratory, B. L. MATHUR.  
Rajasthan, Udaipur, H. C. SANKHLA.  
March 16, 1963.

1. Marlatt, R. B., *Plant. Dis. Rept.*, 1958, 42, 667.

### DEVELOPMENT OF STOMATA IN *PSILOTUM NUDUM* (L.) BEAUV.

THE form and arrangement of the neighbouring cells around the guard cells has long been taken as suggesting the mode of their formation.<sup>1</sup> However, the work of Maheshwari and Vasil<sup>2</sup> on the development of the stomata in two species of *Gnetum* has clearly pointed out that the topography of neighbouring cells in adult stomata may not always be a true indication of the mode of their development. This work accordingly emphasizes the need of actual developmental studies of the stomata of those various living forms where the mode of origin of

neighbouring cells is inferred from their arrangement around the adult guard cells. The present study of the ontogeny of the stomata of *Psilotum nudum* was therefore undertaken for

of the neighbouring cells is like that of other surrounding epidermal cells and polar neighbouring cells are not different from lateral ones (Fig. 1D).

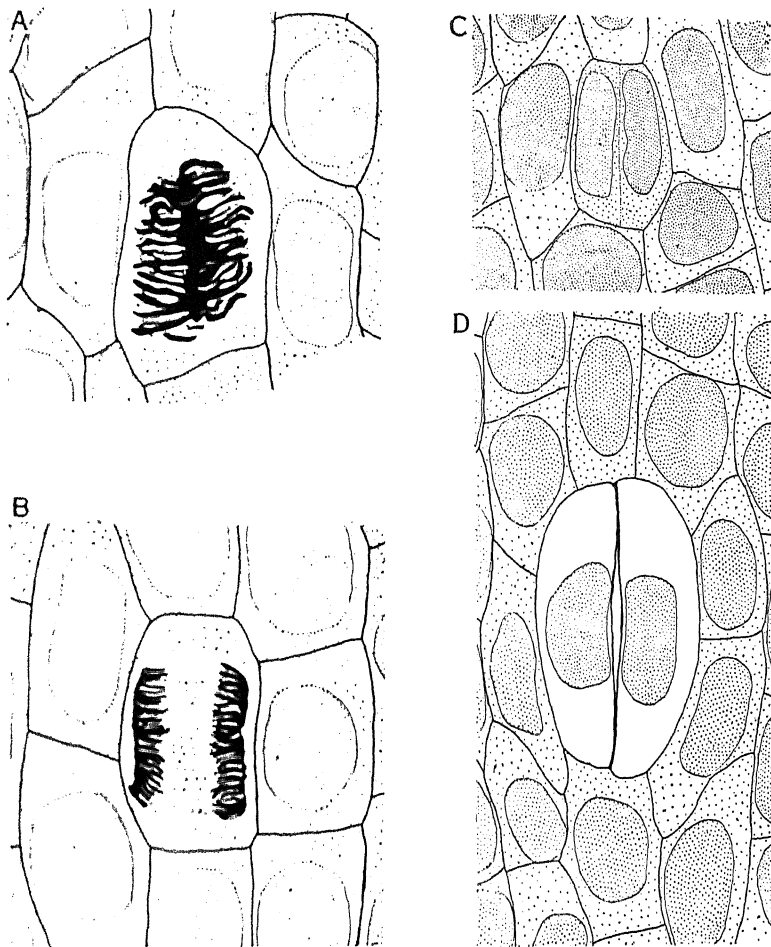


FIG. 1 A-D. Development of stomata in *Psilotum nudum*. A, B. Guard cell mother cell respectively at metaphase and anaphase,  $\times 1,000$ . C. Freshly formed guard cells of a young stoma,  $\times 750$ . D. A young stoma with pore and neighbouring cells,  $\times 750$ .

the same purpose. Division figures of guard cell mother cells were observed in temporary acetocarmine mounts of epidermal peels of the apical portions of the aerial stems of *Psilotum nudum* plants obtained from Trivandrum.

The structure of the mature stomata of *Psilotum nudum* is well known.<sup>3</sup> The epidermal cells in its axis tend to be arranged in longitudinal rows and the monocyclic stomata which occur in the region of the grooves are also normally orientated longitudinally. Their neighbouring cells vary in number usually from 5 to 9 and partially overlap the sunken guard cells. The form

A brief statement about the development of stomata in *P. nudum* was given by Zimmermann<sup>3</sup> but he did not describe the division figures of the guard cell mother cell nor did he mention the mode of formation of the neighbouring cells of the stomata. The protoderm cells a little below the apex divide usually by transverse walls. During the development of a stoma a protodermal cell, which is originally like any other surrounding cells, enlarges in size and becomes the guard cell mother cell. Its enlargement results in its acquiring a more or less oval shape and the rounding up of its corners

(Fig. 1 A). Its contents usually take a lighter stain as compared to the surrounding cells. The nucleus of the guard cell mother cell then undergoes mitosis by forming a transversely placed spindle (Fig. 1 A, B). A longitudinal wall is next formed between the two daughter nuclei (Fig. 1 C) resulting in the formation of two longitudinally elongated guard cells, which continue to enlarge for some time and later a lenticular pore appears between them (Fig. 1 D). The adjacent protodermal cells which happen to surround the guard cells merely undergo slight adjustments in their shape to accommodate the ultimate form of the guard cells but sometimes a neighbouring cell may also divide at one or the other stage of stomatal development. The present study thus confirms that the neighbouring cells of the stomata in *Psilotum* are perigenous in origin resembling the haplocheilic type of *Florin*.

Our thanks are due to the Council of Scientific and Industrial Research for financial help.

Department of Botany, DIVYA DARSHAN PANT.  
University of Allahabad, BHARATI MEHRA.

Allahabad, India,  
March 18, 1963.

1. Florin, R., "Studien über die Cycadales des Mesozoikums," *K. Svenska Vetensk. Akad. Handl.*, 1933, 12, 1.
2. Maheshwari, P. and Vasil, Vimla, The stomata of *Gnetium*, *Ann. Bot.*, 1961, 25, 313.
3. Zimmermann, W., "Die Spaltöffnungen der Psilophyta und Psilotales," *Ztschr. für. Bot.*, 1927, 19, 129.

## A NEW SPECIES OF *HETEROSPORIUM* FROM MARATHWADA

DURING the course of his mycological investigations the writer came across a fungus which was forming brownish to yellowish colonies on stems of *Celastrus paniculata* Willd. The fungus on further investigation was found to be a species of *Heterosporium*. The genus *Heterosporium* is represented in India by only four species of which three have been recorded on leaves and one on fruits. The present collection has been on dead stems of *Celastrus paniculata*. Since there is no record of the above fungus it is proposed to be presented as new to science on the basis of comparative studies and host-relationship.

*Heterosporium celastrinum* TILAK SPEC. NOV.

Conidiophori simplicis, fusci, non-numquam furcati, saepe echinulata, non-septati, magnit

167-190  $\times$  2-2.9  $\mu$ . Conidia ex fusce brunneis rubra, typice ter septate, ex echinulatis verrucosa, magnit 23.2-29 + 7-7.7  $\mu$ .

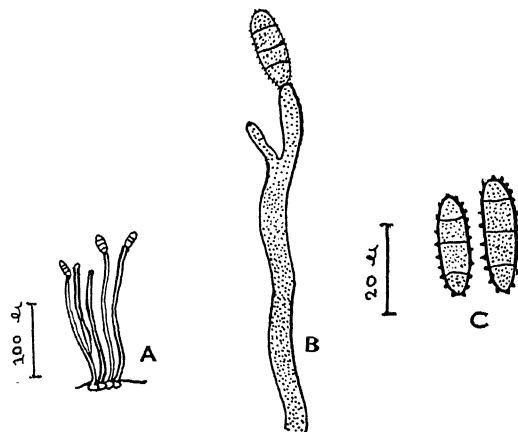


FIG. 1. A. Habit sketch; B. Conidiophore; C. Conidia.

Typus lectus inficiens culmos emortuos *Celastris paniculati* Willd. ad Daulatabad, die 20 februarii anni 1963 a S. T. Tilak et positus in herbario universitatis marathwadadensis sub numero 101.

*Heterosporium celastrinum* TILAK. SPEC. NOV.

Conidiophores dark simple, occasionally branched, oftentimes showing echinulations, non-septate, measuring from 167-190  $\times$  2-2.9  $\mu$ . Conidia dark brown to red typically 3-septate, echinulate to verrucose, measuring from 23.2-29 + 7-7.9  $\mu$ . Saprophytic on dead stems of *Celastrus paniculata* Willd. S. T. Tilak at Daulatabad on 20th February 1963, No. 101 of Marathwada University Herbarium.

It may be noted that the majority of the previous species have been collected on leaves as parasites or saprophytes while the present collection being on stem. Besides the genus is a new addition to the list of Maharashtra State.

The type specimens have been deposited in Herbarium Cryptogamæ Indiæ Orientalia, New Delhi and the Herbarium of Marathwada University.

The author is grateful to Marathwada University for the laboratory facilities and to Dr. H. Santapau for the Latin diagnosis.

Botany Department,  
Marathwada University,  
Aurangabad, March 15, 1963.

S. T. TILAK.

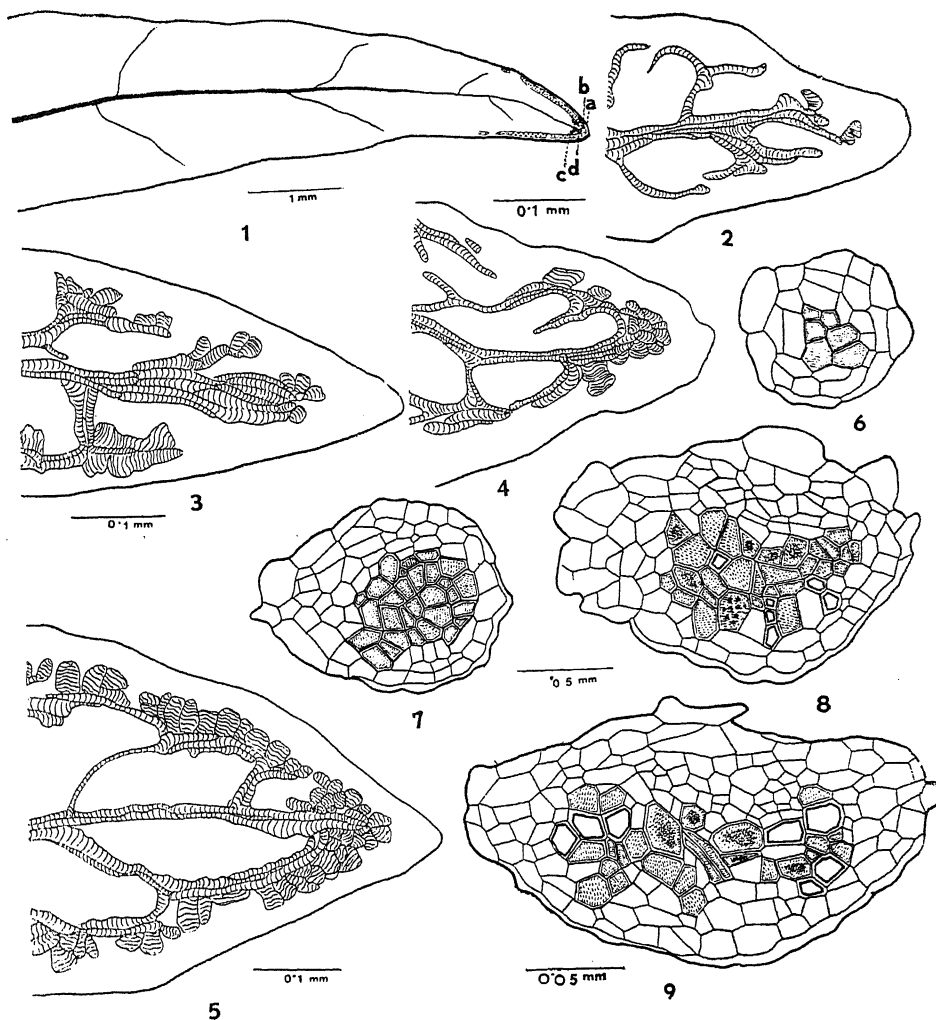
1. Butler, E. J. and Bisby, G. R., *Fungi of India*, Revised, by R. S. Vasudeva, I.C.A.R., New Delhi, 1960, p. 266.

**INTRAMARGINAL TRACHEIDS IN  
*ANTICHARIS LINEARIS* HOCHST.**

*Anticharis linearis* Hochst. is a desert herb usually found on the stabilised dunes. This plant is quite common in certain parts of Rajasthan desert in India. *Anticharis* shows several deviations from other Scrophulariaceous plants in its embryology and pollen morphology. *Anticharis* type of endosperm haustoria and the pollen tetrads are exceptional features for the rest of the Scrophulariaceæ.<sup>4</sup> Being a desert plant several structural peculiarities in the anatomy of the leaf are also noteworthy. The

presence of intramarginal tracheids at the apical portion of the leaf is a feature unrecorded in other members of the family.

Arber<sup>1</sup> has given a passing reference of relative increase in the development of xylem elements as the apex is approached in the leaves of *Triglochin maritima*, *T. bulbosa*, and *T. procera*. Buchenau<sup>3</sup> noted similar feature in the leaves of *Triglochin palustris*. Arber<sup>2</sup> has noted a similar increase in the xylem in the stigmas, just below the papillose region in *Brassica oleracea*, *Rapistrum rugosum* and in *Crambe maritima*. But she has not made any



FIGS. 1-9. Fig. 1. The apical half of the leaf of *Anticharis linearis*, showing the extent of intramarginal tracheids. Figs. 2-5. Apical portions of the cleared leaves at different stages of development. Figs. 6-9. Transverse sections passing through the apical portion of mature leaf from the regions marked a, b, c and d in Fig. 1.

attempt to trace the origin of these structures and so the origin and significance of the intramarginal tracheids are dealt here in some detail.

For the study of the development of intramarginal tracheids, leaves at different stages of development were cleared with hot 10% aqueous potassium hydroxide, washed in water, stained with safranin, dehydrated with alcohol and mounted in glycerine jelly. Some of the leaves were embedded in paraffin wax using xylol as clearing agent. The microtome sections were cut at 10-13  $\mu$  and stained in safranin-fast green combination in the usual way.

In the mature leaf of *Anticharis linearis* the intramarginal tracheids are present at the apical portion only (Fig. 1). In the younger leaves, in which the veins are in the state of development, no marginal tracheids are present (Fig. 2). But as the veins develop, the xylem elements at the apical portion of the midrib shows the development of these structures first. Later on when the maturation of veins approaches the margin lateral vein bifurcates. One of the branches ascends up towards the apex while the other takes a course towards the basal region (Fig. 3). The ascending branch of the lower vein and the descending branch of the vein just adjacent to it clasp together tightly by the sides (Fig. 4).

As the network of veins differentiates, the intramarginal tracheids also start appearing in the apical region to begin with. The xylem elements of the midrib of the lateral veins expand laterally and separate off into cubical segments with spiral thickenings (Figs. 3-5). These are the intramarginal tracheids which may divide to give rise to other tracheidal elements of their own type. At the apex of mature leaf the tracheids group together while in the margins they are restricted to one or two rows (Figs. 6-9). Over the vein ending of the midrib they form more or less a cap-like structure (Fig. 5). Sometimes a sliding growth of the tracheidal elements takes place as Arber<sup>1</sup> noted in *Triglochin* spp. Some of the intramarginal tracheids show much affinity for stains by its localised contents.

The marginal tracheids in *Anticharis linearis* appear to play a very important role in the life-history of the plant. Arber<sup>2</sup> feels that "in foliage leaf and stigma alike, this tendency to lignification is probably connected with the hindrance to the further flow of sap when the distal region of the organ is

approached". The present observation of a 'canopy formation' over the vein endings of the midrib seems to support Arber's suggestion.<sup>2</sup> Moreover the compact holding of the ascending branch of the posterior vein and the descending branch of the adjacent vein and the envelope of the intramarginal tracheids over their surface clearly show that these are devices to check loss of sap in this desert plant. The affinity of some tracheids for deep staining and their localised contents obviously indicate that they may have a storage function also. The envelope over the tip of the vessels with these lignified elements can be considered as a device for protection of the vein endings. It is therefore concluded that all these xerophytic adaptations help this tender non-succulent herb to struggle in desert conditions for a successful life.

The author is extremely thankful to Prof. V. Puri for continuous help and valuable suggestions, to Dr. V. S. Murty and to Dr. N. C. Mathur, for constant encouragement and to the Ministry of Scientific and Industrial Research, Government of India, for a Scholarship, during the tenure of which this has been done.

School of Plant

THOMAS M. VARGHESE.

Morphology,

Meerut College, Meerut, March 5, 1963.

1. Arber, A., *Bot. Gaz.*, 1924, 11, 50.

2. —, *New. Phyt.*, 1931, 30, 11.

\*3. Buchenau, F., *Abt. Naturwiss. Verein Bremen.*, 1896, 13, 408.

4. Joshi, M. C. and Varghese, T. M., *Proc. Indian Acad. Sci.*, 1963, 57, 164.

\* Not seen in original.

### CYPERUS PAPYRUS L.— A NEW RECORD FOR INDIA

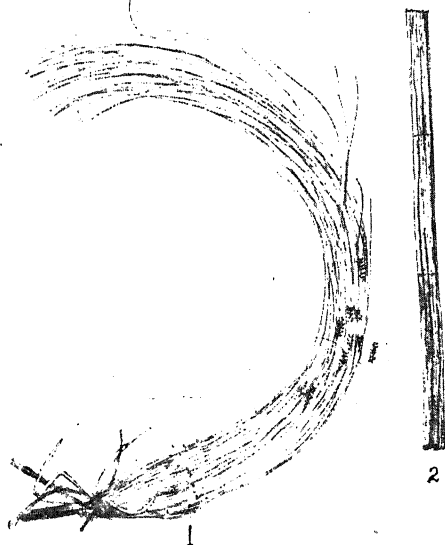
PAPYRUS obtained from the stem pith of *Cyperus papyrus* L. is one of the earliest writing materials of vegetable origin. It was in use among the Egyptians, Assyrians, early Greeks, Romans and probably the other Mediterranean, Asiatic and North African peoples (see Leake, 1952; Baumann, 1960). However, it does not find a mention in the Indian civilization which is older than those just mentioned. Neither the plant has been reported from India by Roxburgh (1820-74), Hooker (1882-97), nor by Cooke (1901-08), Gamble (1915-36), Kanjilal (1934-40) and Blatter and McCann (1934, 1935). Only Bambhadai (1951) mentions its occurrence in India without specifying any locality.

In a recent survey of the Taranga hills in Gujarat state, I came across luxuriant plants of *Cyperus papyrus* L. growing in natural association with *Cyperus rotundus* L., species of *Arundinella* and *Equisetum* sp. at the junction of the two rivers Sabar and Harnav. The plants

may be native somewhere in India also." According to Dr. J. H. Kern (Rijksherbarium, Leiden), "...there are no early records of *Cyperus papyrus* in India....The species is cultivated in Malaysia now-a-days as an ornamental, and so it may occur in India as well."

I am grateful to the Director, Royal Botanic Gardens, Kew, for determining the identification of the plant and the Gujarat University for financial help.

Botany Department, C. K. SHAH.  
Gujarat University,  
Ahmedabad-9, March 12, 1963.



FIGS. 1-2. *Cyperus papyrus* L. Fig. 1. Umbel showing filiform rays. Fig. 2. Stem with hard rind.

of *Cyperus papyrus* reached a height of 2-3 feet. The culms are trigonous and smooth. The stem has a tough rind. The culm terminates in an umbel which bears as many as 100 filiform rays. The rachilla is winged and the spikelets are sessile and chest-nut brown. The glumes are distichous and subtend a trigonous carpel and three stamens.

The origin of *Cyperus papyrus* is much debated. Woenig (1886) feels that it originated in Nubia and then spread down the Nile to the Southern Egypt. It is undoubted that the plant was under cultivation in Egypt but not imported. In a personal communication to me, Dr. Tetsuo Koyama (Cyperologist, University of Tokyo), writes, "If it (*C. papyrus*) is native in India, it will be noteworthy. My data from Eastern Asia are that the plant was wholly under cultivation. Being different from eastern Asiatic flora, the flora of India is closely related to that of North Africa. So *Cyperus papyrus*

1. Bambhadai, G. B., *Vanaspati Srausti—Plant World*, Anand, 1951, 2.
2. Baumann, B. B., *Econ. Bot.*, 1960, 14, 84.
3. Blatter, E. and McCann, C., *J. Bombay nat. Hist. Soc.*, 1934-35, 37, 16, 254, 532, 764.
4. Cooke, T., *The Flora of Bombay Presidency*, London, 1901-08.
5. Gamble, J. S., *Flora of the Presidency of Madras*, London, 1915-36.
6. Hooker, J. D., *The Flora of British India*, Kent, 1882-97.
7. Kanjilal, U., *Flora of Assam*, Calcutta, 1934-40.
8. Leake, C. D., *The Old Egyptian Medical Papyrus*, Kansas, 1952.
9. Roxburgh, W., *Flora Indica*, Calcutta, 1832, Reprint 1874.
10. Woenig, F., *Die Pflanzen in Alten Aegypten*, Leipzig, 1886.

#### DIOCALANDRA STIGMATICOLLIS GYLL., AS A NEW BORER PEST OF THE ARECANUT CROP

SPECIES of *Diocalandra* (Curculionidae) have been recorded as pests of the cocoanut palm in several parts of the orient and Australian regions of the world. Japson recorded its incidence for the first time in Ceylon. Fletcher (1918) first recorded its incidence in India, and the same was later described by Joseph (1949). The incidence of *D. stigmaticollis* as a new borer pest of the arecanut crop in the Mettupalyam tract of the Madras State is recorded below.

The pest attacks the tender portions of the stem even when it is still covered by the leaf-sheath, and the damage is seen on or above the nodes only after the leaves drop off. The damaged portion has the appearance of a deep dent, (such as can be made with a heavy knife) and is obtusely triangular in shape, with the apex pointing towards the growing tip. Viewed from the side, this portion looks like a semi-circular depression in the smooth outline of the stem. The damage can be seen on the successive

internodes as the leaves drop off one by one, invariably on the same side of the stem.

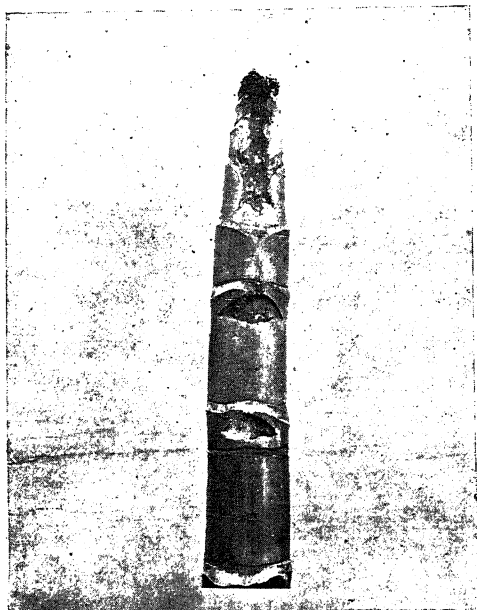


FIG. 1. Severely infected palm.



FIG. 2. The adult and pupa.

The attack is noticed on palms of all ages, the younger plants being particularly susceptible. In one instance the attack had stopped midway and from then on there was normal growth of the plant.

The damage to the stem checks severely the development of the leaves and in severe cases the leaves even fail to emerge. The stem gets

weakened by the damage, and breaks easily on a windy day.

On close examination of the damaged spots, small quantities of frass thrown out by the insects could be noticed here and there, and the grubs could be clearly seen feeding on the tissue. The grubs are dull white, turning to creamy white, with a well-defined brownish head, having well-developed mouth parts made for chewing. They measure 8-9 mm. in length and 2 mm. thick and have about 13 segments. The pupa is creamy white, turning to deep yellow, and has a shiny segmented and furrowed surface, with three prominent dark patches on the pro-thoracic region. The pupal period extends from 12 to 14 days. The adult is brownish, with a darker colouring on its pro-thoracic region, cylindrical, with a prominent curved snout and a pair of antenna, near its base. The head and rostrum are about 1/3 of its total length.

The adult evidently bores through the tender leaf-sheath and lays its eggs on the surface of the stem. On hatching out, the grubs bore through the stem vertically and feed on the stem, producing the characteristic dents.

Regional Arecanut Res. G. V. B. NAIDU.

Station, Hirehalli, S. N. SAMPATH KUMAR.  
March 25, 1963.

1. Fletcher, T. B., *Report of the Imperial Entomologist, Scientific Reports*, Agricultural Research Institute, Pusa, 1917-18, Calcutta, 1918.
2. Japson, F. P., *Report of the Acting Entomologist, Ceylon, Administrative Reports*, Department of Agriculture, Ceylon, 1923.d.-19-D, 1924.
3. Joseph, K. V., "Note on the occurrence of the weevil *Dicalandra stigmaticollis* Gyll., as a pest of the cocoanut palm in Travancore," *Curr. Sci.*, 1949, 18, 173.
4. Maxwell, H. and Lefroy, *Indian Insect Pests*, 1906.
5. Menon, K. P. V. and Pandalai, K. M., *The Cocoanut Palm-A Monograph*.

#### MYROTHECIUM ROT OF TOMATO

A STORAGE rot of tomato fruits, caused by a species of *Myrothecium*, was observed in the local market in November, 1962. Preston<sup>1</sup> reported the occurrence of this fungus on the stems of tomato plants from England. Subsequently Stevens and McColloch<sup>2</sup> reported that it caused a fruit rot of tomato in United States. According to Thirumalachar and Misra<sup>3</sup> it was also responsible for a leaf-spot of tomato in Bihar, India. There is no previous record from India about a fruit rot of tomato by this organism and thus it appears to be the first record of this disease from our country.



The disease first appears in the form of a small nearly circular olive grey patch, the spot appears slightly sunken from the healthy portion of the fruit. The diseased area gradually increases and frequently it gets covered with a copious growth of concentric circles of white wooly mycelium of *Myrothecium*. This is followed by dark green zone of sporodochia with viscid spore mass. The junction between the diseased and healthy tissue remains clearly defined (vide Fig. 1).

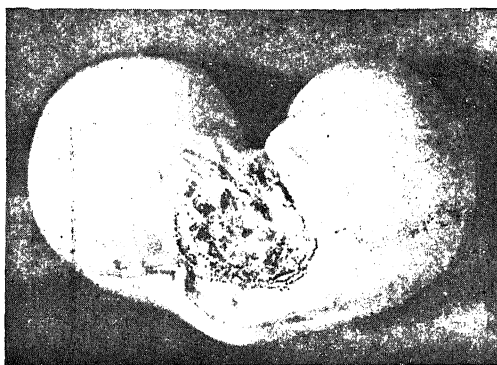


FIG. 1.

Pathogenic nature of the fungus was confirmed by inoculating healthy tomato fruits either by wounding or by contact with agar inocula or by spraying spore suspension. Every fruit was infected when the fungus was inoculated after inflicting slightest injury to the host but only 40% infection was observed on unwounded fruits. In general the fruits rotted completely within 8-9 days.

**Morphology.**—Fructifications or, the sporodochia are sessile, usually very close to each other and usually they become confluent into larger masses, dark green in colour, setae are absent. They arise from pseudoparenchymatous stroma consisting of intertwining conidiophores which are once or twice branched, septate olivaceous green in colour arising from closely appressed layer of phialides. Conidia are cylindrical to elliptical, one-celled with rounded ends, hyaline when young changing to olive green at maturity. They measure  $6-10 \times 2-3 \mu$  (Av.  $9 \times 2.5 \mu$ ). Collectively the spores appear as dark green gelatinous mass.

On the basis of the above morphological characters the organism is specified as *Myrothecium roridum* Tode ex Fries. The culture has been deposited at the Commonwealth Mycological Institute, Kew, Surrey, England, as

No. 96857 and at the Botanical Laboratory, Allahabad University.

We are grateful to Dr. Sutton of Commonwealth Mycological Institute, Kew, England, for confirming the identity of the fungus and to Drs. K. S. Bilgrami and Sudhir Chandra for their help.

Botany Department,  
Univ. of Allahabad,  
Allahabad, India, March 25, 1963.

R. N. TANDON.

M. P. SRIVASTAVA.

1. Preston, N. C., "Observations on the genus *Myrothecium* Tode. I. The three classic species," *Trans. Bri. Mycol. Soc.*, 1943, **26**, 158.
- \*2. Stevens, J. A. and McColloch, L. P., "*Myrothecium* as a tomato fruit rot organism," *Plant. Dis. Repr.*, 1947, **31**, 147.
3. Thirumalachar, M. J. and Mishra, J. N., "Some diseases of economic plants in Bihar, India," *F.A.O. Pl. Prot. Bull.*, 1953, **2** (1), 11.

\* Originals not consulted.

#### THE CHROMOSOME NUMBER OF *CYAMOPSIS SERRATA* SCHINZ

THE genus *Cyamopsis* is composed of 3 species. *Cyamopsis tetragonoloba* (L.) Taub. is a cultivated plant grown throughout the Indo-Pakistan sub-continent and in the South-Western part of the United States. Ayyangar and Krishnaswamy observed that the chromosome number of the species is 7. *Cyamopsis senegalensis* Guill. and Perr. grows wild from Senegal to the Sudan. Hymowitz has shown that the chromosome number of the species is 7. The third species of the genus *Cyamopsis serrata* Schinz is found in South Africa and the chromosome number is reported here for the first time.



FIG. 1. Somatic chromosomes of *Cyamopsis serrata* ( $2n=14$ ).

Seed of the species was collected at Kimberly, South Africa and sent to the United States,

Plant Introduction Number 279564 was assigned to them by the U.S. Department of Agriculture. The seed was multiplied at the Oklahoma State Experiment Station and brought to India by the senior author.

The chromosome count was made from root tip cells of germinated seed using a squash technique. The seeds were individually scarified and placed on moist filter-paper in petri dishes. Primary radicles were removed after they had emerged from the seedcoat about 5-10 mm. The root tips were placed in a 0.1% colchicine solution for 30 minutes. After decanting the colchicine, the root tips were placed in a 22% acetic acid and N HCl mixture (12:1) and kept for 15 minutes at 60° C. Then the root tips were washed in water and hydrolyzed in N HCl for 10 minutes at 60° C. The root tips were washed and placed in leuco basic-fuchsin for 20 minutes and then squashed in aceto-carmin.

As shown in Fig. 1 the somatic chromosome number is 14. Hence, all the species in the genus are diploids with  $n=7$ .

Division of Botany,  
Indian Agric. Res. Inst.,  
New Delhi, April 13, 1963.

T. HYMOWITZ.  
M. D. UPADHYA.

1. Ayyangar, G. N. R. and Krishnaswamy, K., *Ind. J. Agr. Sci.*, 1933, 3, 934.
2. Hymowitz, T. (Unpublished).

#### **JATROPHA CURCAS, L., A COLLATERAL HOST FOR *OIDIUM HEVEAE*, STEIN.**

*Hevea brasiliensis* is affected by *Oidium heveae* in most of the rubber-growing countries in Asia and Africa. But in its native habitat in the Amazon Valley this disease does not occur. Recently there are reports of the outbreak of *Oidium heveae* in Sau Palo in Southern Brazil (Rosetti, 1958). Many euphorbiaceous plants in the Eastern hemisphere are infected by *Oidium* spp., some of which are indistinguishable from *O. heveae*. Therefore it is conjectured that the powdery mildew of *Hevea*, first noticed in Java in 1918, might have passed on to *Hevea* from some other host in that region. Its spread to other countries might have been through the planting material (budwood). Working on this hypothesis Young (1952) investigated the disease and reported that the *Oidium* on *Hevea* infected *Euphorbia hirta*, L. and the one on this passed on to *Hevea*. *E. hirta* is a common weed in many rubber-growing areas. There is a mildew (*O. cyparissiae*, Syd.) prevalent on this host. It was also stated that the mildew on *Hevea* could survive on this

alternative host during certain months in the year.



FIG. 1. Leaf of *J. curcas* infected by *O. heveae*.

Experiments conducted in Malaya (Ann. Rept. RRIM, 1949) and S. India revealed that the *Oidium* on *E. hirta* is not able to infect rubber. These results are opposed to the findings of Young. *O. heveae* is able to survive throughout the year on *Hevea* itself. The search for collateral hosts was however continued. We have been able to establish that *O. heveae* can infect the leaves of *Jatropha curcas*. Tender and half mature leaves are readily infected. Infection can take place through both surfaces. The incubation period is 5 to 7 days. The veins in the mildew-affected areas turn reddish-brown. The surface growth of the leaf is checked and it becomes crinkled. Sporulation is more when the relative humidity is above 90%. From the affected *Jatropha* plants the spores were transferred to young *Hevea* leaves. Mildew spots were formed in 4 to 5 days. Thus it was established that *J. curcas* is a collateral host for *O. heveae*. This is the first record of this host for this pathogen. Rubber Res. Inst., T. S. RAMAKRISHNAN, Kottayam, P. N. RADHAKRISHNA PILLAY. July 18, 1963.

1. Rosetti, V., *Biologica*, 1958, 24, 265.
2. Young, H. E., *Quart. circ. Rubb. Res. Inst. Ceylon*, 1952, 27, 3.
3. Reports, *Ann. Rep. Pathology Division, Rubb. Res. Inst. Malaya*, Report for 1949, 1953,

## REVIEWS

**Numerical Solution of Ordinary and Partial Differential Equations.** Edited by L. Fox. (Addison-Wesley Publishing Company, Inc., Reading, Massachusetts), 1962. Pp. 509. Price \$ 10.00.

The book has been written on the basis of the material presented at a Summer School for representatives of industry, government, universities and technical schools held at the University Computing Laboratory, Oxford, England, in September 1961. The material of the book is divided into the following four parts containing in all 36 chapters, (i) Ordinary Differential Equations, (ii) Integral Equations, (iii) Introduction to Partial Differential Equations, (iv) Practical Problems in Partial Differential Equations. About 16 authors have participated in the writing of the book each dealing with his own speciality.

While dealing with the first three basic chapters the contributors have attempted to include, either fully, briefly or by reference all the important known facts and techniques and have indicated the lines for the further development of these topics. Throughout in the treatment of the subject they have kept the electronic computing machine in view and have discussed the relative merits of the various techniques from the point of view of accuracy, convergence and stability of solution. In describing the techniques the ease of coding and convenience of machine computation have been kept in mind.

The purpose of bringing out this book is to present the techniques to the persons who have to apply them, so that underlying mathematical details have been avoided.

Chapter IV deals with the techniques of solution of current problems of interest derived from diverse fields like Reactor Physics, Fluid Mechanics, Plasma Physics, Weather Prediction.

The presentation of the subject-matter is clear and lucid and printing attractive. The book will be found to be extremely useful by the teachers and the students dealing with scientific and technical subjects and also by the persons who are only interested in using the techniques of numerical solution of differential and integral equations.

The reviewer has great pleasure in recording that Prof. Fox has earned the gratitude of the readers by bringing out this valuable book.

P. L. BHATNAGAR.

**Mathematics in Science and Engineering (Vol. 6)—Differential Difference Equations.** Edited by R. Bellman and K. L. Cooke. (Academic Press, Inc., New York-3, N.Y.), 1963. Pp. xvi + 462. Price \$ 13.75.

Within about 450 pages the authors have remarkably succeeded in giving a detailed and systematic account of a new theory which has numerous and important applications in Physics, Engineering, Economics and Biology, namely that of equations of the form

$$\frac{dx}{dt} = g[x(t), x(t-t_1), \dots, x(t-t_h), t]$$

or of the form

$$u(t) = \int_0^t g(s) u(t-s) ds.$$

Various techniques are developed, in particular, that of the Laplace transform which is introduced with a minimum of knowledge of Analysis. Existence and uniqueness theorems are established under various conditions and an extremely interesting study of the asymptotic behaviour and of the stability of the solutions is made. The book can be read with great profit by students with a Master degree and provide them with a variety of problems for a Ph.D. thesis. Indeed one finds at the end of each chapter an extremely rich and remarkably interesting number of exercises and of what the authors call "Research Problems".

C. RACINE.

**Pulse Circuits—Asia Monographs, I.** By B. Chatterjee. (Asia Publishing House, Bombay-1), 1963. Pp. viii + 159. Price Rs. 10.

This monograph aims at the discussion of the basic principles of operation and design of ordinary pulse circuits. It deals with linear and non-linear pulse shaping circuits, delay lines, pulse generators such as blocking oscillators, multivibrators, etc., wide-band amplifiers, trigger circuits and counters. A short chapter treats of pulse measurements and some information is included about radar displays and pulse measurements.

The book is intended to cover a course on pulse circuits offered to communication engineering students at the Indian Institute of Technology, Kharagpur, as a preparatory course for Television and Radio Aids to Navigation. The level at which the subject is treated is about the same as found in modern text-books on electronics, except for the chapters on delay lines and counting circuits, which are treated in more detail. An Appendix on Laplace transforms has been included, which will prove useful to students who have not had a course on this subject in their mathematics curriculum.

The explanation of the operation of pulse circuits is generally satisfactory but the following comments have to be made. In Chapter 2, the author makes a distinction between clipping and limiting which are not clear. Further, only circuits using diodes are treated and triode and pentode circuits are omitted. In Chapter 4, dealing with pulse amplifiers, the transient response, which is so important, has not been dealt with. In many waveforms shown, the time and voltage co-ordinates are omitted (*vide* pp. 14, 15, 83, 89). More careful editing is also called for in respect of figures, some of which are in error (*vide* Figs. 6.6, 9.15) and others do not have tube numbers ( $T_1$ ,  $T_2$ , etc.) indicated (*vide* Figs. 6.9, 8.1) to tally with the explanation in the text. None of the circuits have any values of components or of tube types indicated and in the opinion of the reviewer, it is a serious omission, for, at least a few typical circuits with values of components would have helped the students to get a feeling for pulse circuits. A set of problems and questions at the end of the chapters would have increased the usefulness of the book.

The book achieves the limited aims which the author has set himself but its general usefulness could have been increased by a more detailed treatment and by the elimination of the shortcomings mentioned above.

N. S. N.

**Advances in Electrochemistry and Electrochemical Engineering**, Vol. 1. *Electrochemistry*. Edited by Paul Delahay. (Interscience Publishers, Inc., New York), 1961. Pp. ix + 326. Price \$ 12.00.

In the recent years a number of books dealing with topics of current interest not generally covered by classical text-books or reviewing up-to-date knowledge on suitable subjects have been published in serial form as "Advances".

Such series have become quite popular. The present book is the first of a new serial "Advances in Electrochemistry and Electrochemical Engineering". The aim is "to make available the authoritative reviews in the area of electrochemical phenomena, and to bridge the gap between electrochemistry as a part of physical chemistry and electrochemical engineering". This volume deals with some modern aspects of electrochemistry.

It contains five articles, three of which concern with the electrode reactions on metal/solution interface, the fourth the semiconductor electrodes and the last one, the measuring methods for fast electrode reactions. The first article by R. Parsons deals with structures of double layer especially the inner layer, the adsorption of neutral substances, the effect of double layer on the kinetics of electrode reactions. The author points out the inadequacy of the simple theory of Frumkin, who first realised the importance of double layer on electrode kinetics, and suggests some possible modifications. In the next review on "Hydrogen Overvoltage and Adsorption Phenomena: Pt. I, Mercury", A. N. Frumkin discusses the importance of double layer on the hydrogen overvoltage reaction and the effect of specific adsorption of anions and even cations, the presence of neutral and cationic organic molecules, of organic bases, and also of excess of hydrogen or hydroxyl ions in the solutions, etc., on the hydrogen overvoltage at the mercury cathode. M. Breiter in his contribution points out the role of some factors on oxygen overvoltage and rate-determining steps in anodic processes. In the article on "Semiconductor Electrode Reactions", H. Gerischer, after outlining the fundamental concepts of semiconductor, discusses the distribution of charge at the semiconductor/electrolyte interface, the charge transfer process by ions and electrons, kinetics of electrodes and finally compares the experimental results with the theoretical concepts. In the last article, P. Delahay describes the theory and the techniques of relaxation methods which are used for the study of fast electrode processes in unstirred solutions. It is of particular interest to note that the Faradaic rectification method (Redoxokinetic effect) discovered by Doss and Agarwal has been modified for fast reaction also.

The topics dealt in the present volume are of great interest to all electrochemists. Despite a little overlapping of subject materials in some articles which cannot completely be

avoided in such books, these authoritative reviews coming from well-known experts will be of immense value to all research workers who are interested in recent developments in electrochemistry. The present volume fulfils the promise and it is hoped that the others following it will also do the same. This series according to the reviewer will be another welcome addition to the increasing number of recent "Advances".

A. G.

#### Laboratory Organization and Administration.

By K. Guy. (Macmillan & Co. Ltd., London), 1962. Pp. xiv + 386. Price 50 sh.

This is an extremely useful book and contains a wealth of information on almost every practical aspect concerned with planning, organization, administration, maintenance and inspection of scientific laboratories. Such minute details as are given on almost every problem which usually arises in the running of a science laboratory in schools, colleges, and research establishments, can only be the result of experience, and the author's accumulated knowledge obtained from his wide experience is evident on every page and illustration in the book.

The book is written to cover the syllabus on the subject of the title prescribed for the Laboratory Technicians' course leading to the Certificate examination conducted by some institutes in London. Unfortunately in India there are no such courses and men in charge of laboratory organization and maintenance have to train the assistants themselves, and to them this book will be of great help.

The following chapter headings will indicate the range of topics covered in the book: (1) Designing the laboratory; (2) Installation of laboratory equipment; (3) Stores management; (4) Preparation and storage of reagents; (5) Inspection and maintenance; (6) Safety in the laboratory and the workshop; (7) Special needs of teaching laboratories; (8) Optical projection; (9) Laboratory records and technical information; (10) Organization of demonstrations and exhibitions; (11) Training of laboratory technicians.

Great thought has been given in writing each chapter and nothing of importance has been omitted. In the chapter on records and technical information, for example, there are sections on Filing and documentation, Copying processes including the offset lithographic process and microcopying. Sections on silvering and

preparation of lantern slides for projection might have been usefully added.

This book is warmly recommended to all schools and colleges in India.

A. S. G.

Nuclear Graphite. Edited by R. E. Nightingale. (Academic Press, New York), 1962. Pp. xiii + 547. Price \$ 15.80.

This book is intended to serve as a reference for those concerned with the development and use of nuclear graphite. The first chapter by the editor himself discusses the historical aspects of nuclear graphite and develops the subject-matter to the time when the first radiation effects were observed. Then follow chapters in regular sequence dealing with manufacture, machining practice, properties, structure, radiation effects and reactor systems and designs.

About 20 authors have contributed to this work, and naturally the treatment is not coherent or of a uniform standard. In a subject in which the scientific understanding is still in a fluid state such variations in depth of treatment are to be expected. However, an effort has been made to present the different views of controversial subjects, and this naturally adds to the usefulness of the publication to those scientists and engineers concerned with the development of graphite technology.

A. S. G.

The Biology of Cilia and Flagella. By M. A. Sleight. (Pergamon Press), 1962. Pp. xiii + 242. Price 70 sh.

Cilia and flagella have commanded the attention of biologists almost since 1675 when Leeuwenhoek first saw cilia in a Protozoan. Their almost universal occurrence among animals (they have been reported absent only in the nematoda), their mode of functioning and their structure have been examined, but during the past two decades, there have been significant additions to our knowledge,—of structure, by the electron microscope, and of functioning, by modern biochemical methods. The remarkable constancy of the basic fibril pattern (9 + 2) occurring in both cilia and flagella, revealed by the electron microscope, has brought the two structures together. It is even more remarkable that with this similarity of structure, cilia and flagella exhibit different modes of functioning. Dr. Sleight has presented a summary of recent developments in our knowledge of these structures.

Curiously, the beating patterns of flagella are simpler than those of cilia, though in both, a number of structural compounds,—the central and peripheral fibrils, the basal bodies and the investing membrane,—are involved. Analysis of these factors has brought out a certain similarity between ciliary movement and muscular contraction.

Dr. Sleight's special studies relate to the mechanisms of co-ordination in the beat of cilia and he devotes a chapter to an analysis of these mechanisms. Both synchronous and metachronal beats occur; the latter are highly complex and only recently there has been an attempt at their analysis and classification. Thus in *Opalina* there appears to obtain a transmission mechanism different from that in another ciliate *Stentor*. There is evidence to suggest, however, that the transmission moves step-by-step along a row of cilia, involving two stages in each step: an interciliary conduction process and an intraciliary excitation process.

It is not claimed that this account of cilia and flagella is the last word on the subject; rather, it marks the beginning of a series of inquiries into the complex patterns of their functioning in the light of their simple and uniform structural pattern.

B. R. S.

---

Some Aspects of the Relative Efficiencies of Indian Languages—A Study from Information Theory Point of View. By B. S. Ramakrishna, K. K. Nair, V. N. Chiplunkar, B. S. Atal, V. Ramachandran and R. Subramanian. (Department of Electrical Communication Engineering, Indian Institute of Science, Bangalore), 1962. Pp. xii + 90. Price Rs. 4.00 or \$1.00 or sh. 6.

This small book by Ramakrishna *et al.* is the first of its kind to deal with a comparative statistical study of Indian Languages from the point of view of communication in the wake of the statistical theory of communication formulated by Norbert Wiener and Claude E. Shannon.

The authors have demonstrated with success that "where different languages can be employed to serve the same purpose, we can compare their relative performances as alternative means of communication using the tools of communication theory" (Preface, -p. vii) in an objective and quantitative way. This is perhaps one of the few works of its kind dealing with a number of languages at once, and such a study with the Indian languages has a scientific and social

significance in the prevailing technological-cultural developmental context in India.

The authors have successfully tried to find answers to the questions "(i) given that it is possible to convey the same idea or semantic content by two different languages, which of the two is more efficient for communication? and (ii) given also that it is possible to transcribe a given verbal expression or phonetic content into written symbols by two different scripts, which of the two is more efficient in the sense that it requires less time?" (Preface, p. vii).

The book is meant not only for the professional reader but also for the general reader who is concerned in any way with the problems of communication efficiencies of the different Indian languages and scripts. To facilitate the general reader's understanding of the subject-matter, the authors have done well to include basic introduction to the statistical notions and methods involved "out of the conviction that every technical writer must have the courtesy to give his reader enough explanation to enable him to read his work through and not drive him to the nearest library in search of an obscure reference" (Preface, p. viii). It is to the credit of the authors that they have succeeded in large measure in this respect also.

The book brings the communication aspect of language (the primary aspect) into prominence. In this connection it may be noted that the scientifically objective, non-sentimental, investigations of the authors have shown, for example, that (Ch. IV, p. 25) English is 25% more efficient in transmitting a given semantic content in comparison to Hindi.

As regards the Indian scripts in comparison to the Roman script, the authors' results show (1) that Tamil, Kannada and the Devanagari (Marathi and Hindi) scripts, in their overall pattern of writing, are less efficient than the Roman script in writing the respective languages, and (2) that Telugu and Malayalam scripts are just as efficient as the Roman script in writing the respective languages.

The authors have used the phonetic symbols [θ] and [ð] to represent the dental stop consonants, though the IPA (International Phonetic Alphabet) phonetic value for the symbols is that of a fricative. Perhaps one should take it that (since the authors have shown extreme care in handling the rest of their material) they have used these symbols to mean the fricatives when referring to English and to mean the dental stops when referring to the

Indian languages. Similarly they seem to have equated the alveolar stops [t] and [d] of English to the retroflex stops of the Indian languages, for purposes of comparison in their study.

The authors, however, have not specified what corresponding letters or combinations they have used in Roman to represent the Indian sounds [ñ], [ŋ], [l], as well as [ɭ], and [ɻ] (of Tamil).

The syllabic breakdown especially of words of more than one syllable carried out by the authors is something that should have been clarified further. If, as they say, the "syllabic breakdown of the sentence follows its characters" (p. 13, footnote), it is not stated as to how they decided to break up a sequence like VCCV. If they decided in favour of VC-CV, on what grounds, for example, V-CCV was excluded is something that should have been made explicit. Is the process of syllable breakdown the same for all the Indian scripts? If not, what is the basis of comparison, syllable for syllable? Is one to assume that a uniform method of syllable breakdown is followed for all scripts so that a one-to-one correspondence is guaranteed for different syllabic patterns in any two scripts compared?

Though it is a small book, an index would have added to the usefulness of the book.

Apart from the few shortcomings pointed out above, the reviewer finds this book to be an important landmark in the study of Indian languages from the communication point of view.

P. C. GANESHSUNDARAM.

#### Books Received

*Naturally Occurring Oxygen Ring Compounds.*

By F. M. Dean. (Butterworth & Co. Pub. Ltd., 88, Kingsway, London W.C. 2), 1963. Pp. viii + 661. Price 120 sh.

*A Dictionary of Scientific Units.* By H. G. Jerrard and D. B. McNeill. (Chapman & Hall, London W.C. 2), 1963. Pp. 197. Price 21 sh.

*Essays on Protozoology.* By H. Sandon. (Hutchinson Educational Ltd., 178-202, Gt. Portland St., London W. 1), 1963. Pp. 142. Price 15 sh.

*The Study of Fossils.* By J. F. Kirkaldy. (Hutchinson Educational Ltd., 178-202, Gt. Portland St., London W. 1), 1963. Pp. 116. Price 15 sh.

From : (Academic Press, Inc., New York-3, N.Y.):

*Structure and Ultrastructure of Micro-organisms.* By E. M. Brieger. 1963. Pp. xvi + 327. Price \$ 10.00.

*Study Projects in Physical Chemistry.* By F. E. Condon. 1963. Pp. xii + 203. Price \$ 4.75.

*Malnutrition and the Eye.* By D. S. McLaren. 1963. Pp. xix + 390. Price \$ 15.50.

*Progress in Nucleic Acid Research*, Vol. I. Edited by J. N. Davidson and W. E. Cohn. 1963. Pp. xiv + 424. Price \$ 13.00.

*Chemical Technology—A Series of Monographs*, (Vol. I)—*Fuel Cells.* Edited by W. Mitchell, Jr., 1963. Pp. xv + 442. Price \$ 15.00.

*Insect Pathology, an Advanced Treatise*, (Vol 2). Edited by E. A. Steinhaus. 1963. Pp. xiv + 689; Price : until October 1963, \$ 20.00; there-after, \$ 23.00.

*Physical Chemistry* (Vol. 12)—*Colloidal Surfactants—Some Physico-Chemical Properties.* (Editors : Eric Hutchinson, P. Van Rysselberghe), 1963. Pp. v + 310. Price \$ 11.50.

*Comparative Endocrinology* (Vol. 1)—*Glandular Hormones.* Edited by U. S. Von Euler and H. Heller. 1963. Pp. xii + 543. Price \$ 20.00.

*Clinical Biochemistry of Domestic Animals.* Edited by C. E. Cornelius and J. J. Kaneko. 1963. Pp. xii + 678. Price \$ 20.00.

*Progress in Astronautics and Aeronautics* Vol. 9—*Electric Propulsion Development.* Edited by Ernst Stuhlinger. Pp. xiii + 748. Price \$ 10.50; Vol. 10—*Technology of Lunar Exploration.* Edited by C. I. Cummings and H. R. Lawrence. 1963. Pp. xv + 989. Price \$ 13.75.

*Introduction to Modern Biochemistry.* By Peter Karlson. (Translated from German by C. H. Doering), 1963. Pp. xvi + 433. Price \$ 10.00.

*Canadian Cancer Conference.* Edited by R. W. Begg. 1963. Pp. xii + 479. Price \$ 14.00.

*Informational Macromolecules.* Edited by H. J. Vogel, V. Bryson and J. O. Lampen. 1963. Pp. xix + 542. Price \$ 16.50.

*Advances in Cancer Research*. (Vol. 7). Edited by A. Haddow and S. Weinhouse. 1963. Pp. ix + 599. Price \$ 18.00.

---



---

## SCIENCE NOTES AND NEWS

---



---

### Award of Research Degrees

The M.S. University of Baroda has awarded the Ph.D. Degree in Physics to Shri V. P. Bhatt for his thesis entitled "Study of Some Metal Crystals"; the Ph.D. degree in Mathematics to Kumari K. Savithri for her thesis entitled "Quadratic Forms over the Field of Rational Functions in One Variable over a Finite Field"; and the Ph.D. degree in Zoology to Shri N. V. Vallyathan for his thesis entitled "Studies on Certain Metabolic Adaptations in the Avian Pectoralis and the Blood".

Bombay University has awarded the Ph.D. degree in Physics to Shri Y. R. Waghmare of Physical Research Laboratory, Ahmedabad, for his thesis entitled "Theoretical Studies in the Structure of Light and Intermediate Nuclei".

### Symposium on 'Utilisation of Metallurgical Wastes'

The Director, National Metallurgical Laboratory, Jamshedpur, India, informs that a symposium on "Utilisation of Metallurgical Wastes" is being organized by the National Metallurgical Laboratory to be held early in February 1964. Intending participants may kindly write to the Dy. Director, NML, for further information.

### International Conference on Cosmic Rays

The Eighth International Conference on Cosmic Rays, under the auspices of the International Union of Pure and Applied Physics, will be held in Jaipur from the 2nd to the 14th of December, 1963, at the invitation of the Department of Atomic Energy, Government of India.

The Conference will cover the following broad fields: (i) Primary cosmic radiation, (ii) Solar particle radiation, (iii) Phenomena at energies greater than 30 GeV; (iv) Cosmic ray muon and neutrino physics.

Further information can be had from Dr. R. R. Daniel, Secretary, Organising Committee for the International Conference on Cosmic Rays (1963), Tata Institute of Fundamental Research, Colaba, Bombay-5, India.

### Symposium on Elastic-Plastic Deformation

The Eighth Congress and Symposium on Elastic-Plastic Deformation will be held from

October 10 to 12, 1963 at the University of Delhi, Delhi. Further information may be obtained from the Secretary, Prof. B. R. Seth, I.I.T., Kharagpur.

### The Institute of Physics and the Physical Society

The Institute of Physics and the Physical Society announces that its 1964 Exhibition of Scientific Instruments and Apparatus will be held in the Halls of the Royal Horticultural Society, Vincent Square, London S.W. 1, from 6 to 9 January 1964.

The 1965 Exhibition will be held in the first week of April, in The Manchester College of Science and Technology.

### Occurrence of Ostracoda in the Upper Cretaceous Rocks of South India

Shri S. P. Jain, Department of Geology, Panjab University, Chandigarh-3, writes:

A recent examination of the material from the Ariyalur stage of the South Indian Cretaceous System has revealed the presence of a rich ostracode fauna in these rocks. A total of 18 species belonging to nine genera have so far been identified. Check-list of the species found is given below:

*Bairdia trigona* (Bosquet), *B. dentifera* Veen, *B. decumana* Veen, *Bairdia* sp. 1, *Bairdia* sp. 2, *Bythocypris goeulandensis* Alexander, *B. kiritheformis* Bonnema, *Candona* sp., cf. *C. mantelli* Jones, *Asciocythere prompta* (Lubimova), *Cythere multilamella* (Bosquet), *Cytherella ovoidea* (Alexander), *C. subreniformis* Jones and Hinde, *C. scotti* Alexander, *Cytherelloidea granulosa* (Jones), *Paracypris acuta* (Cornuel), *P. tenicula* Alexander, *Paracypris* sp., *Monoceratina transisleana* Bonnema.

### New Host Plant of *Celosterna scabrator* Fabr. (Order: Coleoptera)

Shri J. C. Basu Choudhuri of the Department of Entomology, Forest Research Centre, Coimbatore-2, writes:

The babul root borer, *Celosterna scabrator* Fabr. (Fam.: Cerambycidae), was first reported to be a pest on babul by the Conservator of Forests, Berar, in July 1892. Since then it has gained status as a serious insect pest and is recorded on the following host plants: Family:



Casuarinaceae—*Casuarina equisetifolia* Linn.; Family: Dipterocarpaceae—*Shorea robusta* Gaertn. f.; Family: Leguminosae—*Acacia arabica* Willd., *A. catechu* Willd., *Cassia siamea* Lam.; *Pithecolobium dulce* Benth.—*Prosopis juliflora* D.C., *P. spicigera* Linn.; Family: Rhamnaceae—*Zizyphus jujuba* Lam.; Family: Verbenaceae—*Tectona grandis* Linn. fil.

During the recent insect surveys of forest insect pests in South India the insect has been found on *Eucalyptus* sp. (hybrid?) grown in Chingleput Forest Division. The nature and extent of damage caused to young eucalyptus indicate that the insect is a potential pest of eucalyptus.

For the first time the pest is recorded on *Eucalyptus* sp. (hybrid?) (Family: Myrtaceae) in Paranur Plantation, Chingleput Range and Mayyur R.F., Chingleput Forest Division (Madras State).

*Trichuris discolor* (Linstow) from Goat in Orissa

Shri M. M. Patnaik, Parasitologist (Veterinary), Bhubaneswar-3, writes:

*Trichuris ovis* Abildgaard and *T. globulosa* Linstow are the two common whipworms found in the caeca of Indian goats (Deo, P. G., *Indian J. Vet. Sci.*, 1960, 30, 139-45). Literature on the occurrence of *T. discolor* Linstow, 1906, in goat is rare. It is a less common species found in goats in Orissa. Among other helminths, a total of 119 adult specimens (33 males and 86 females) of this species was encountered in the cecum and colour of a eight-year old stud-goat, autopsied at Ghatgaon, Orissa, for the first time.

On the Occurrence of Copper in Gomoh-Topchanchi Area (Bihar)

Shri Bharat Prasad, Geology Department, Patna University, Patna, reports the occurrence of copper minerals, in the metamorphosed basic rocks in the village Khesmi (86° 15' N : 24° 30' E). The country rocks comprise felspathic schists and older gneisses of Dharwar age. The basic rocks now represented by epidiorites occur as sills in them. The entire group has been isoclinally folded, the general strike and dip being N 110° and N 10° respectively. The latest event in this area is marked by the emplacement of a granodiorite, veins and offshoots of which occur widely distributed throughout this region. The granodiorite proper is situated a couple of miles to the north of this locality.

The epidiorites have been severely affected by this acidic intrusion. Veins of different size occur in them and invariably the contact is marked by retrograde changes and appearance of several new minerals. Among the latter are the copper minerals, chalcopyrite, arseno-pyrite and bornite. They occur as pockets, veins and lodes in these epidiorites near their contact with the acidic material.

Such an association has not been so far reported from this country and it opens a very wide field of investigation. The genesis of these ores seems to be connected with the hydrothermal phase of the acidic intrusion in this area.

Vibrational Raman Intensities in Gases

Theories of vibrational intensities of Raman bands are strictly applicable to conditions in which disturbing intermolecular interactions are absent. Study of vibrational Raman intensities in gases will thus prove more useful than in liquids to test theories and derive fundamental molecular data. Until recently experimental investigations in this respect have been mostly confined to liquids because of the practical difficulties in vibration intensity measurements in gases. However, with improved techniques in sample illumination and use of multiple reflection cells it is now possible to obtain photoelectrically recorded Raman spectra for gases which are comparable in quality with those obtained from a liquid.

Such records especially in the case of spherically symmetrical molecules and for the fundamental modes of vibration enable correlation to be established between intensities and bond polarisability.

D. A. Long and E. L. Thomas using these improved techniques have measured the vibrational Raman intensities for the  $\nu_1(a_1)$  modes of  $CD_4$ ,  $CF_4$ ,  $SiF_4$ ,  $SF_6$ ,  $SeF_6$  and  $TeF_6$  all in the gaseous state and at pressures 1-2 atm. and compared them with the  $\nu_1(a_1)$  of  $CH_4$  obtained under identical conditions. Relative bond polarizability values have been obtained for these molecules.—(*Trans. Farad. Soc.*, 1963, 59, 1024.)

Hypothesis of Earth's Behaviour

While the well-known principle of isostatic adjustment allows vartical displacements of continents, the question arises whether they can be moved about in horizontal directions by the rifting of the ocean floor in some places and its compression and overriding at others.

There are three evidences to show that great horizontal displacements of the earth's crust have occurred: (1) measurements of rock magnetism suggest that continents have moved independently relative to the poles; (2) well-known faults are known to have undergone horizontal displacements of tens or even hundreds of miles at different geological times; (3) oceanic islands tend to increase in age with distance from mid-ocean ridges.

According to Prof. J. T. Wilson, if parts of the crust have been shifted horizontally relative to other parts, it must have stretched or rifted along some lines and compressed or overridden along others. If they have done so then the likely places are the mid-ocean ridges. Therefore, Prof. Wilson suggests that "submarine ridges provide a second precise method of fitting continents together in addition to that used by Wegener and Du Toit".

From the study of submarine ridges two generalizations can be made: First, where a mid-ocean ridge lies half-way between two continents, they were once in contact. Secondly, the ends of lateral ridges and the fit of shore lines may be used to reassemble them in the positions in which the once lay.

Prof. Wilson applies these generalizations to the case of Gondwanaland and says that to create the Indian Ocean by rifting required the separation of four continents, Africa, India, Australia and Antarctica, and that in addition to the three known median ridges there should be a fourth extending north-easterly between India and Australia. If it does exist it will no doubt be discovered during the International Indian Ocean Expeditions.—(*Nature*, 1963, 198, 925.)

### The Lachrymatory Factor in Onion

Although it is generally known that the lachrymatory factor (LF) in onion is a sulphur-containing compound, the exact nature of the compound has not been well established. One method of approach to characterize the LF will be to assume that it is enzymically formed from a non-volatile and essentially stable precursor when onion is cut or crushed, and attempt at isolating this precursor. C. G.

Spare and A. I. Virtanen have reported the results of their experiments in *Acta Chemica Scandinavica* (1963, 17, 641). The precursor has been found as (+)-S-(prop-1-enyl)-L-cysteine sulfoxide. An enzyme preparation of onion splits it into the lachrymatory factor, pyruvic acid, and ammonia. The LF is very unstable. In mass-spectral studies of the enzymic cleavage of the lachrymatory precursor no mass number higher than 90 could be detected. These studies indicate that the LF is propenylsulphenic acid. It is spontaneously degraded to propionaldehyde from which some 2-methyl-2-pentenal is formed. In mild alkaline solution the precursor of the LF is cyclized to cycloalliin.

### Statement on Meteorological Rockets

The region between 30 and 100 km. is known to be the seat of many phenomena that are related to the rest of the atmosphere and it is a link between the part of the atmosphere that is most sensitive to solar changes and the lower atmosphere.

Meteorological rocket systems now being developed offer the opportunity to bring this entire region under observation. Already meteorologists have learned about some significant features of the upper atmosphere, such as the following: (a) The flow and the thermal structure in the upper stratosphere (30-50 km.), the mesosphere (50-80 mm.), and lower ionosphere appear to be at least as complex as those noted on synoptic charts for the lower regions. There are moving disturbances and at certain times there are dramatic and violent changes in the flow that appear to start at the higher levels and progress downward. One such phenomenon, known as "stratospheric sudden warming", occurring in the late winter or early spring, has been observed on a number of occasions.

(b) A well-pronounced semi-annual variation of the wind and horizontal temperature gradient has been deduced from meteortrail observations at 80 to 100 km., suggesting that in some respects the lower ionosphere is coupled with the regions above, where a similar semi-annual effect has been observed from satellite drag measurements.

## THE COLOURS OF GEMSTONES

SIR C. V. RAMAN

COLOUR is the sensation experienced by an observer when he views the material under study. It is, therefore, essentially a subjective phenomenon. While the optical properties of the material alter the spectral character of the light falling thereon and emerging therefrom which reaches the eye of the observer, the visual impression which such light produces is determined by the physiological characteristics of the sensory apparatus. These characteristics accordingly play the leading role in the perception of colour and must necessarily take precedence in all considerations regarding the subject.

In a memoir by the writer which has been recently published (Reference 1), the results of systematic studies on floral colours have been described and discussed. The products of the plant world, including especially the leaves and flowers of living plants, constitute a very large class of materials exhibiting colour which invite study. Being products of biological activity, they conform to set patterns and are therefore exceptionally well suited for precise scientific investigations. The number of species of flowering plants is enormous, and the colours displayed by their flowers are of the most varied nature. Further, not merely is the material available in abundance, but it is also available in forms and sizes exceptionally well suited for a spectroscopic examination. It is only to be expected in these circumstances that the studies would be richly rewarding and this has indeed proved to be the case. The observational data which the studies have yielded are of a comprehensive nature and have been obtained by methods which do not involve any particular assumptions or hypotheses regarding the visual mechanism and what it is or is not capable of achieving.

In other words, they represent the results of an unbiased study of the facts and therefore give us a true picture of the reality.

It emerges clearly from the studies on floral colours that the ideas regarding colour composition and colour perception based on the so-called trichromatic hypothesis are inadmissible and have of necessity to be totally rejected as being inconsistent with or contradicted by the real facts of the case. As an example of such inconsistencies and contradictions, we may mention here the circumstances in which the well-known sensation of "purple" is actually perceived. Numerous flowers exhibit that colour, and spectroscopic examination reveals that it arises from the more or less complete extinction of the narrow range of wavelengths between  $560\text{ m}\mu$  and  $590\text{ m}\mu$  which constitutes the yellow sector of the spectrum, all other parts of the spectrum remaining unaffected. This result, even taken by itself, is a complete refutation of the entire framework of ideas embodied in the so-called trichromatic hypothesis.

Another class of objects which exhibit colour and are worthy of study form the subject of the present communication, namely gemstones. In several respects, they are an antithesis to the products of the plant world when considered from the present point of view. For a material to be classed as a gemstone, it must be a rarity or at least so scarce as to be an expensive commodity, usually available only in small pieces and generally only after it has been converted by lapidaries into a form calculated to exhibit its lustre and beauty to the maximum extent and for that same reason wholly unsuitable for any precise scientific investigation of its spectroscopic behaviour. It is

the rarity and costliness of the gems which are natural products which motivated the efforts made to produce them synthetically, thereby creating for buyers and sellers alike, the acute problem of distinguishing between the natural and synthetic gemstones. Nevertheless, such questions, as for example, why is emerald green, why is ruby red and why is sapphire blue, possess both a human and a scientific interest. One can, of course, escape the difficulty of obtaining material suitable for the studies by employing the synthetic instead of the natural gems. But, then, the interest of the investigation and of its results would be materially diminished.

To the reader interested in gemstones and the practical problems arising in the identification of gemstones and of distinguishing between natural and the synthetic gems, Mr. B. W. Anderson's book on gem-testing (6th Edition, Heywood and Co., London) may be heartily recommended. The following remarks made by him which are pertinent to the subject may usefully be quoted here: "Minerals can be classified into the idiochromatic ('self-coloured') type which owes its colour to an element which is an essential part of its composition—e.g., the iron in almandine garnet or peridot, the copper in malachite—and the allochromatic type, in which the colouring element is present in quite small quantity as an 'accidental' impurity. The majority of gem minerals are allochromatic: that is, the mineral itself has no distinctive colour, and is in fact colourless when pure, but exhibits a range of coloured varieties according to the presence of traces of different colouring elements. Quartz, beryl, corundum, tourmaline, topaz, spinel, zircon, and many others are in this category."

Anderson's book also contains a chapter on the use of the spectroscope in gem-testing which contains material relevant to the present topic, *viz.*, the colours of gemstones. In that chapter are reproduced four charts which contain drawings made from visual

observations of the spectra of 35 different gemstones, grouped together under the four headings of red, yellow, green and blue stones. The spectra exhibit very varied features, and this fact is of considerable assistance in the identification of the gemstones. The usefulness of the charts from this point of view should not however be allowed to obscure the fact that they cannot serve as a basis for the explanation of the colours of the gemstones. It is not merely the positions of the absorptions noticeable in the spectrum of the gemstones, but also the strength of such absorptions that has to be considered in relation to the intensity of the unabsorbed parts. In other words, we need a complete picture of the energy distribution or at least of the visual luminosities in the spectrum of the light emerging through the gemstone before we can proceed to consider the explanation of its visually observed colour.

It is naturally to be expected that the results which have emerged from the studies on floral colours would be found to be equally well applicable to the case of gemstones and enable us to give a satisfactory interpretation or explanation of their colours. The interest of the subject and the fact that a considerable collection of gem minerals was available in the museum of the Raman Research Institute induced the author to undertake some preliminary studies in this field with a view to find whether this is actually the case. The present communication is a brief report on the results.

We may first consider the case of emerald. The rich green colour characteristic of this gem is exhibited by numerous pieces of beryl purchased by the author some years ago at Jaipur in Rajputana and included in the collection of beryl specimens of various sorts deposited in his museum. Unfortunately, however, none of these specimens is transparent enough to permit of light transmitted in the regular fashion through it

being observed or examined. However, the author was presented by Sri. Chand Golecha, a leading jeweller of Jaipur, when he recently visited Bangalore, with a hexagonal crystal of beryl from the Colombian mines about one centimetre thick. The two faces of the plate facing each other were ground down and polished, and the material was then found to be fairly transparent and the transmitted light also exhibited the characteristic green colour of emerald. Visual spectroscopic examination, confirmed by photographically recorded spectra, showed that in the passage of light through the plate, the violet and blue sectors of the spectrum were noticeably weakened, especially the former. But there was a readily observable transmission in the wavelength range between  $450\text{ m}\mu$  and  $500\text{ m}\mu$ . The green and the red sectors of the spectrum were also visibly diminished in their intensities in the light emerging through the plate. But such diminution was not more than could reasonably be ascribed to the loss by reflection at the two surfaces of the plate as well as the imperfect transparency of the material. On the basis of these facts, we should have expected the colour of the light emerging through the emerald to be a bright yellow, while actually it was a clear green.

We have now to consider the explanation of this striking discrepancy. There is indeed a weakening of intensity (including a narrow band of absorption) noticeable at and near the red end of the spectrum. But the visual luminosity of this part of the spectrum is so small that such absorption is incapable of explaining the fact that the observed colour of the gem is green and not yellow. A careful examination of the spectrum shows, however, that the part of the spectrum between  $570\text{ m}\mu$  and  $600\text{ m}\mu$ , in other words, the yellow sector of the spectrum is greatly weakened. It is clear that it is this extinction of the yellow that is responsible for the observed colour of emerald.

The results obtained with the hexagonal beryl crystal were confirmed with a fine piece of emerald of gem quality which was purchased from a jeweller at Bangalore. It is of much smaller thickness (about two millimetres) but exhibits a deep green colour. The yellow of the spectrum is found to be greatly weakened in the passage of the light through the gem. The aggregate intensity of the red sector relatively to the green sector is distinctly less than it is before entry into the gem, but it is far from being negligible. The observed vivid green hue of the emerald indicates that in the circumstances of the case, the visual sensation excited by the red sector is more or less completely masked by that of the more luminous green sector, in other words, prevented from influencing the perceived colour of the gem.

We shall next consider the case of the ruby. The author's collection of corundum from Ceylon includes numerous individual specimens exhibiting varied colours. Placing them under the ultra-violet lamp and picking out those which exhibit the characteristic red glow enables us to separate the rubies from other species of corundum. Such separation resulted in the interesting discovery that some rubies exhibit a purple colour. They show a strong absorption in the region of wavelengths between  $560\text{ m}\mu$  and  $590\text{ m}\mu$ , in other words, of the yellow sector in the spectrum. Their spectral behaviour thus closely resembles that of the purple flowers mentioned earlier.

Rubies which appear red owe their colour to the existence of an absorption covering both the yellow and green sectors of the spectrum. It is a remarkable fact that the blue of the spectrum is transmitted more or less freely by such rubies. But it does not appear to influence the observed colour. We are led to infer that in the particular circumstances of the case, the weaker sensation due to the blue part of the spectrum is

masked or prevented from being perceived by the more luminous red sector.

Flowers which appear of a blue colour invariably exhibit a strong absorption of the yellow of the spectrum. A very similar behaviour is found to be exhibited by blue sapphire.

We may sum up all that has been said above in a few words, *viz.*, that the colours of gemstones exhibit features which are in complete accord with those met with in the realm of flowers (Reference 1).

1. Raman, Sir C. V., "Floral Colours and the Physiology of Vision," *Memoir No. 137 of the Raman Research Institute*, pp. 57 to 108.

## ROLE OF ATOMIC ELECTRONS IN NUCLEAR TRANSFORMATIONS

**A**N International Conference on the Role of Atomic Electrons in Nuclear Transformations was held in Warsaw on September 24 to 28, 1963. This Conference, which was jointly sponsored by the International Union of Pure and Applied Physics, International Atomic Energy Agency and the Polish Academy of Sciences, was attended by about 200 delegates, drawn from some 20 countries, including U.S.A., U.K., U.S.S.R., Germany, Italy, France, Canada, Japan, India, the Netherlands and Scandinavia. Among the delegates who attended were Professor M. E. Rose and Professor K. Siegbahn. The programme consisted of some 10 review talks and presentation of about 60 research papers. The language of the Conference was English.

This Conference brought together nearly all the groups in different parts of the world, working in those areas of nuclear spectroscopy in which the interaction between the nucleus and the atomic orbital electrons plays an important role. These areas are: (1) Internal conversion of gamma-rays, (2) Orbital electron capture decay of nuclei, (3) Auger effect, (4) Internal bremsstrahlung, (5) Internal pair creation and (6) Influence of atomic electrons on beta-decay.

In an illuminating talk, Professor M. E. Rose surveyed the present status and theoretical background of internal pair creation. Dr. T. R. Gerholm from Siegbahn's laboratory at Upsala reviewed nuclear structure effects in the internal conversion process. He reiterated the view that such effects may profitably be studied in the

case of retarded M1 and electric monopole type of transitions. A large number of interesting papers on measurements on internal conversion were presented from Chalk River, Canada, the Swedish groups, Vanderbilt University, Tennessee and Tata Institute, Bombay. The K-conversion coefficients for pure E2 transitions in the deformed, rare-earth nuclei have so far been reported to be as much as 20% higher than the theoretical values of Rose and of Sliv. The paper from the Bombay group reported agreement with theory to within 10%, after careful evaluation of all possible sources of error, in the case of such transitions for some eight nuclei in the deformed region. This evoked considerable interest and discussion at the Conference. Another interesting point which emerged was that, for low energy gammas, the internal-external conversion (IEC) method will involve considerable correction for scattering of photoelectrons in converter. The values of conversion coefficients obtained by this method may, therefore, have to be revised. The Polish groups working at the Institute for Nuclear Research have been concentrating mainly on Electron capture ratios for different shells and internal bremsstrahlung.

The general impression after the Conference was that a great deal of fundamental work yet remains to be done on these aspects of nuclear spectroscopy, in which the atomic electrons play a role in nuclear transformations.

Tata Institute of Fundamental  
Research, Bombay-5.

B. V. THOSAR.

# ROLE OF BLUE-GREEN ALGAE, CHEMICAL NUTRIENTS AND PARTIAL SOIL STERILIZATION ON PADDY YIELD

L. L. RELWANI AND R. SUBRAHMANYAN

*Division of Blue Green Algae, Central Rice Research Institute, Cuttack*

IN an earlier account,<sup>1</sup> the possibilities of increasing paddy yield by inoculation of nitrogen-fixing blue-green algae were indicated. Intensive work was further undertaken in pot house and field in 1962 on *Main season* crop (July-November) to study the role of indigenous and the introduced forms of blue-green algae in combination with chemical nutrients and partial soil sterilization. Medium duration variety T. 141 was used.

The treatments consisted of (i) inoculation with blue-green algae (*Anabaena* sp. in pots and mixture of *Anabaena*, *Nostoc*, *Microcystis*, *Phormidium* and *Aphanothece* in the field), (ii) partial soil sterilization (20 lb. pressure for 1 hour in autoclave in pots and heating of top 10 lb. of burning straw on ploughed land in field) and (iii) application of nutrient mixture (nitrate of lime (1,000 Kg./ha.), superphosphate (20 Kg./ha.) and sodium molybdate (0.25 Kg./ha.), Ammonium sulphate at 20 Kg./ha. was used in one of the treatments to compare the yield response in terms of this popular fertilizer for paddy.

About one gram of *Anabaena* alga in vegetative stage was collected from G Block of Central Rice Research Institute and paddy pots of Cytopentrich. It was diluted with water

immediately after collection. A portion of this was then put into wide-mouthed one pound screw-capped cylindrical bottles, filled to  $\frac{3}{4}$  capacity, and shaken vigorously till a homogeneous suspension was formed. This process was repeated 7-8 times and the contents were transferred into 2,500 ml. winchester bottle. After a final vigorous shaking in this bottle for a uniform mixing, 100 ml. aliquots were poured in the required pots after transplanting in the pot house. A similar second application was given to the pots a fortnight after the first one. In the field, blue green moist scrapings along with surface soil, consisting of *Anabaena*, *Nostoc*, *Microcystis*, *Phormidium* and *Aphanothece*, were collected from all over the campus of the Central Rice Research Institute, thoroughly mixed into a homogeneous mass and weighed in lots of 500 gm. Each of such samples was then thoroughly mixed in a bucket of water and sprinkled uniformly in each of the required plots. The bucket was rinsed with water twice and the washings applied in a similar manner.

The precautions taken in the conduct of field experiment have been reported in the previous communication.<sup>1</sup> Yields of paddy, grain and straw in pots and field are given in Table I and pot experiments illustrated in Figs. 1 and 2.

TABLE I  
Yields of paddy grain and straw

Treatment	Pots (gm. per pot). Average of five replications		Field (Kg. per hectare). Average of four replications					
	Grain	Straw	per cent. increase over control		Grain	Straw	per cent. increase over control	
			Grain	Straw			Grain	Straw
Control (control A)	10.43	14.25	..	..	2379.47	3795.91	..	..
Partial sterilization	19.24	41.72	181.30	192.77	2857.82	4560.97	20.10	20.15
Control alga	10.81	16.09	3.64	12.91	2578.39	4000.74	8.36	6.98
<i>Anabaena</i> alga	27.04	34.82	151.25	144.15	2577.87	4716.78	25.15	26.36
Control + superphosphate + sodium molybdate (without soil sterilization)	11.03	11.95	5.75	-1.42*	2642.09	4706.95	23.64	25.58
Control + superphosphate + sodium molybdate (with soil sterilization)	33.81	43.86	218.89	207.79	3489.41	5049.72	46.65	48.84
Control alga	15.67	24.85	50.24	74.19	2741.15	5561.44	44.62	46.51
<i>Anabaena</i> alga	39.17	47.12	275.76	266.28	3061.25	4826.27	53.87	58.04
<i>Anabaena</i> alga + superphosphate at 20 kg./ha.	11.20	18.07	8.24	26.81	2062.59	4825.80	26.19	27.13
Control	11.39	12.64	..	..	±47.83	±118.17	..	..
S. Fm.	4.70	7.58	..	..	189.27	263.47	..	..

\* Per cent. decrease over control.

It will be seen that: (1) The effect of blue-green algæ alone (Treatment C) was small, i.e., 3.64% grain and 12.91% straw in pots and 8.36% grain and 6.98% straw under field conditions over untreated control (Treatment A).

in pots and 44.62% grain and 46.51% straw in the field. This combination was significantly superior to nutrient mixture or algæ applied separately. Thus, chemical nutrients like lime, superphosphate and sodium molybdate appear

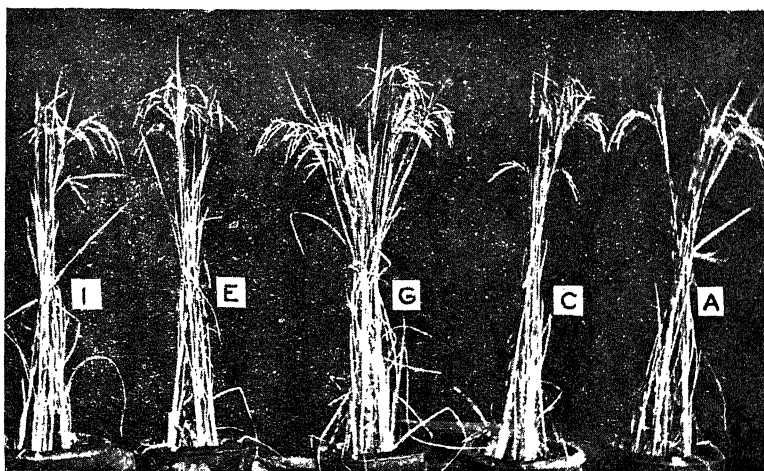


FIG. 1. Photograph of pot culture experiment. Treatments: I, Ammonium sulphate, 20 Kg. N/ha.; E, Lime (1 000 Kg.), superphosphate (20 Kg.  $P_2O_5$ ) and sodium molybdate (0.28 Kg.) per ha.; G-E, + algæ; C-A, + algæ; A, Control (untreated).

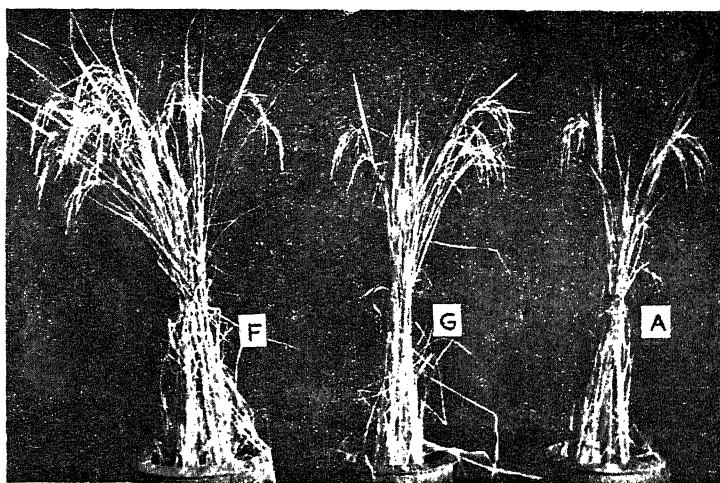


FIG. 2. Photograph of pot culture experiment. Treatments: F, Lime (1,000 Kg.), superphosphate (20 Kg.  $P_2O_5$ ), sodium molybdate (0.28 Kg.) per ha. + partial soil sterilisation; G, Lime (1,000 Kg.), superphosphate (20 Kg.  $P_2O_5$ ) and sodium molybdate (0.28 Kg.) per ha. + algæ; A, Control (untreated).

(2) The nutrient mixture itself (Treatment E) significantly increased the yields of grain and straw by 23.64% and 25.58% respectively over control treatment under field conditions but not in pots.

(3) The combination of algæ and nutrient mixture (Treatment G) produced pronounced increases of 50.24% grain and 74.39% straw

to considerably increase the efficacy of blue-green algæ. The beneficial role of these nutrients on the growth and increased activity of nitrogen-fixing blue-green algæ has been reported by earlier workers.<sup>2-10</sup> Lime, by raising the pH of the soil to alkaline reaction also provides a favourable medium for the growth of blue-green algæ.



(4) The effect of partial soil sterilization (Treatment B) was found to be considerable. In the pots, increased yields of 181.30% grain and 192.77% straw over the control were recorded. In the field, lower but significant responses of 20.10% grain and 20.15% straw were obtained. Partial soil sterilization in the case of pots also hastened the ripening of crop by 5-6 days.

(5) Partial soil sterilization in combination with nutrient mixture (Treatment F) recorded further increases in yields of grain and straw in pots and field.

The beneficial effect of soil heating or partial sterilization may be due to the improvement in the physical properties of soil, killing of undesirable groups of pathogens, parasites and weeds and to increase in the production of ammonia, nitrates and other available mineral plant nutrients.<sup>11, 14</sup>

(6) The highest increases of 275.56% grain and 236.28% straw in pots and 53.87% grain and 58.04% straw in the field over control were obtained with combination of partial soil sterilization, nutrient mixture and blue-green algae (Treatment H).

It is evident from these findings that partial soil sterilization, and blue-green algae in the

presence of nutrient mixture contribute to increase in paddy yields.

The authors thank Dr. R. H. Richharia, Director, for providing facilities and for his keen interest and encouragement in the present investigations.

1. Relwani, L. L., *Curr. Sci.*, 1963, **32**, 417.
2. De, P. K. and Sulaiman M., *Soil Sci.*, 1950, **70**, 137.
3. — and Mandal, L. N., *Ibid.*, 1953, **81**, 453.
4. Okuda, A. and Yamaguchi, M., *Soil and Plant Food*, 1955, **1**, 102.
5. Jha, K. K., *Proc. Rice Research Workers' Conference* (1959), Cuttack, I.C.A.R., New Delhi, 1961, p. 266.
6. Singh, R. N., *Role of Blue-Green Algae in Nitrogen Economy of Indian Agriculture*, I.C.A.R., New Delhi, 1961.
7. Okuda, A., Yamaguchi, M. and Nioh, I., *Soil Sci. and Plant Nutrition*, 1962, **8** (3), 35.
8. Wilson, P. W., *Asymbiotic Nitrogen Fixation*, *Handb. d. Pflanzenphysiol.*, 1958, **8**, 9.
9. Baldanzi, G., *Bot. Tech. Inst. Agron. Soil. (Pelotas)*, 1959, **25**, 3. [*Biot. Abs.*, 1962, **38** (5), No. 20042.]
10. Vitranen, A. I., *Proc. III Internat. Congr. Biochem. Brussels* (1955), 1956, p. 425.
11. Bolley, H. L., *Science*, 1911, **33**, 229.
12. Mann, H. H., Joshi, N. V. and Kanitkar, N. V., *India-Dept. Agri. Mem. Chem. Ser.*, **2** (3), 141.
13. Sreenivasan, A. and Aurangabadkar, R. K., *Soil Sci.*, 1940, **50** (6), 449.

# A STUDY OF THE POLLEN GRAINS OF *JUSSIEUA* AND *LUDWIGIA* WITH REMARKS ON THE TAXONOMIC STATUS OF *JUSSIEUA SUFFRUTICOSA* LINN.

J. VENKATESWARLU AND V. SESHAVATARAM

Department of Botany, Andhra University, Waltair

THE family Onagraceae constitutes about 500 species distributed among 40 genera which are temperate and tropical.<sup>1</sup> Embryologically the family is of special interest because of the universal occurrence of monosporic tetranucleate embryo-sac known as the Oenothera type, having been demonstrated in more than 16 genera.<sup>2</sup> A majority of the species studied exhibit a remarkably homogeneous and most fundamental type of embryonomy known among the angiosperms.<sup>3</sup> Warming (1932) describes the pollen grains of the family to be well pronounced, triangular and connected together by viscous threads. Evertman (1952) gave a detailed palynological account of the family and remarked that the pollen grains of the family are not similar to those of any other family. As far as the writers are aware, *Jussieuia repens* Linn., *J. suffruticosa* Linn. and *Ludwigia parviflora* Roxb. have not been studied

palynologically. Hence the present study is undertaken.

The material was collected from paddy fields and the nearby areas in the West Godavary District of the Andhra Pradesh. The pollen bearing material was suspended in glacial acetic acid and acetolysed, a part of which is chlorinated. Both acetolysed and chlorinated pollen grains were mounted under the same coverslip in glycerine jelly.<sup>4</sup>

## *Jussieuia repens* LINN.

Pollen grains free and not united in tetrads, triporate, angulaperturate, ora alongate, sexine thicker than nexine with a fine granular structure (Table I, Fig. 1).

## *Jussieuia suffruticosa* LINN.

Pollen grains united in tetrads with a mean diameter of 123  $\mu$ . Tetrads tetrahedral, with

apertures uniting according to Fischer's rule.<sup>4</sup> No viscin threads were observed protruding out of the margins of the grains. Pollen grains triporate, angulaperturate, ora lalongate, raised above the surface of the grain with a conspicuous rim at the periphery and a similar one at the base. Sexine thicker than nexine, finely granular (Table I, Fig. 2).

Ludwigia parviflora Roxb.

Pollen grains united in tetrahedral tetrads with a mean diameter of 60  $\mu$ . Aper'tures of the grains uniting in tetrads according to Fische:r's rule. Pollen grains triporate, angulaperturate, ora lalongate, raised above the surface of the grain (cf. *J. suffruticosa*). Sexine thicker than nexine. No viscin threads were observed protruding out of the pollen grain margins (Table I, Fig. 3).

TABLE I

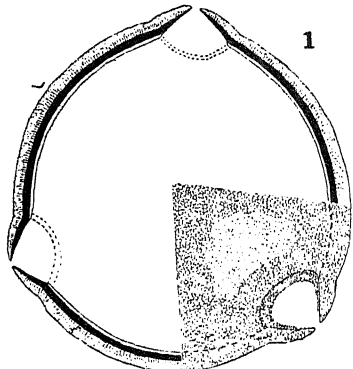
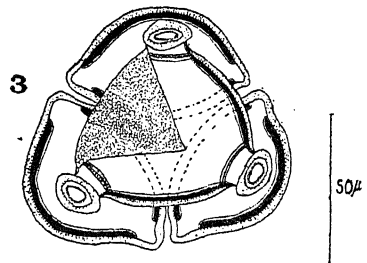
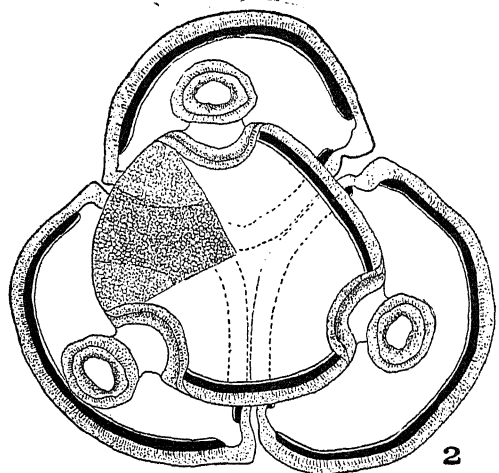
Showing the morphological characters of the pollen grains

Name	Size ( $\mu$ )			Thickness ( $\mu$ )			Diameter of the pore ( $\mu$ )
	Tetrad	Polar view	Equit'ral view	Exine	Sexine	Nexine	
<i>Jussieua repens</i>	..	61.88	83.98	5.90	3.95	1.95	11.18
<i>J. suffruticosa</i>	152.85	60.18	87.42	5.26	3.44	1.82	9.42
<i>Ludwigia parviflora</i>	60.12	33.47	45.17	3.68	1.95	1.13	5.72

\* Averaged from 10 observations.

The occurrence of pollen grains in tetrads connected by viscid protoplasmic threads has been considered by Pope (1925) to be of a normal feature of the family Onagraceae. Erdtman (1952), on the other hand, considers this feature to be of less frequent occurrence. In *Bosiduvalia densiflora* he reports pollen grains united in tetrahedral tetrads. His descriptions of pollen grains of *Jussieua grandiflora* and *Ludwigia paulstris* indicate in both the cases that the pollen grains are free from one another and not united in tetrads. The present study of *Jussieua repens* clearly shows that the pollen grains are not united in tetrads but are free as in *J. grandiflora*. On the other hand, *J. suffruticosa* and *L. parviflora* have their pollen grains united in tetrahedral tetrads, a feature not found in *J. repens*, *J. grandiflora* and in *L. paulstris*. The last named plant may well be *Jussieua paulstris* as indicated by DeCandolle (1828). Incidentally, it may have to be mentioned here

that *J. suffruticosa* resembles more of *L. parviflora* in other morphological features also than *J. repens*. A comparative account of the morphological features of the three species included in the study is given in Table II.



FIGS. 1-3. Fig. 1. *Jussieua repens*, pollen grain. Figs. 2-3. Pollen tetrads of *J. suffruticosa* and *Ludwigia parviflora*.

From the above it is clear that *J. suffruticosa* seems to be more closely allied to *L. parviflora* than to *J. repens*. DeCandolle (1828) did not

TABLE II

Showing morphological features of *Jussiaea repens*, *J. suffruticosa* and *Ludwigia parviflora*

Character	<i>Jussiaea repens</i>	<i>Jussiaea suffruticosa</i>	<i>Ludwigia parviflora</i>
Habit	Herbaceous water plant with prostrate stems rooting at the nodes	A semi shrubby erect perennial, 4 to 6 ft. high	Erect herb, 6 inch. to 2 ft. high
Stem	Hollow and round	Angular	Angular
Flower	Pale yellow or white, pedicels long	Yellow, pedicels short	Yellow, small, pedicels very small
Calyx and corolla	5 merous, petals clawed	4-merous, petals broadly obovate	4 merous, petals elliptic, oblong
Stamens	Ten	Eight	Four
Capitula	Cylindric, 5-valved	Subquadrate, 4-valved	Quadrangular, 4-valved

consider *J. suffruticosa* as a species of *Jussiaea* but includes it under 'species not satis notae'. The evidence from pollen morphology shows that what is commonly regarded as *J. suffruticosa* by the taxonomists is to be treated as a species of *Ludwigia*.

1. Wickett, L. C., *The Embryology of Flowering Plants and Fungi*, Cambridge Univ. Press, 1951.
2. Maheshwari, S., *An Introduction to the Embryology of Angiosperms*, McGraw-Hill Book Company, New York, 1950.

3. Johansen, D. A., *Plant Embryology*, Chronica Botanica, Waltham, Mass., U.S.A., 1950.
4. Erdtman, G., *Pollen Morphology and Plant Taxonomy*, Chronica Botanica, Waltham, Mass., U.S.A., 1952.

DeCandolle, A. P., *Prodromus Systematis Naturalis Regni Vegetabilis*, Part III, 1828.

Pope, M. A., "Pollen morphology as an index to plant relationship. I. Morphology of the pollen grain," *Bot. Gaz.*, 1925, 80, 62.

Warming, K., *A Handbook of Systematic Botany*, George Allen & Unwin Ltd., 1932.

## PRESENT STATUS OF ONION SMUT IN INDIA AND ITS CONTROL

N. V. R. URS, H. C. GOVINDU<sup>1</sup> AND P. R. MEHTA<sup>2</sup>

**S**TRAY attacks of onion smut *Urocystis cepulae* (Schlecht.) Rabenh. (*U. cepulae* Frost) was observed and recorded for the first time by M. J. Narasimhan in 1920 (cf. S. V. Venkatakrishna's paper in *Curr. Sci.*, 1960, 29, 324) from Mysore. The disease was observed again in 1958 and 1959 by Venkatakrishna<sup>2</sup> near Melur village, Kolar District. The disease was noticed to occur in the same field in both the years over an area of about half an acre. In view of the serious nature of the disease, all the onion growing areas of the State were thoroughly surveyed and the authors could locate only one infested field of about 3½ acres near Chennarayana of Bangalore District. The two localities where smut was observed recently are seven miles apart. The crop in the infested field in both the localities was destroyed by burning and at Melur the soil was drenched with 0.5% solution of Ceresan

wet. Cultivation of onion was also banned in the affected fields.

Since India exports large quantities of onion, particularly a variety known in the trade as 'Bangalore onion', which is grown in Mysore State and elsewhere and because the presence of the disease was jeopardising the export trade, numerous steps are being taken to eradicate the disease and to prevent its spread. The measures taken are enumerated below:

(i) Declaring the area within a radius of 1.6 kilometers of the infested fields under the Pests and Diseases Act of the State.

(ii) Not to permit the cultivation of onion in infested fields for about six years in the first instance.

(iii) Not to allow the export of onion from the areas declared under the Pests and Diseases Act.

(iv) To allow planting of the area under (i) only with onion seeds pelletised with an appropriate fungicide.

Since (i) to (iii) are administrative measures, these are not discussed herein. Work carried

<sup>1</sup> Division of Plant Pathology, Agricultural Research Institute, Hebbal, Bangalore-24.

<sup>2</sup> Directorate of Plant Protection, Quarantine and Storage, New Delhi.

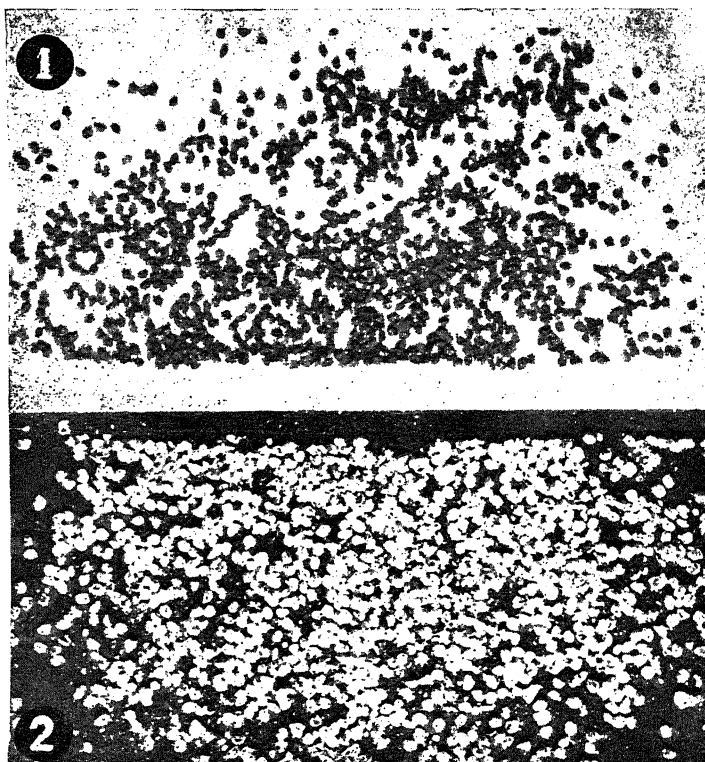
out to determine the efficacy of various fungicides is described below.

The onion crop in Kolar and Bangalore Districts is usually raised by broadcasting seeds; transplanting seedlings raised in nurseries is not commonly practised. Since only one variety is grown, it has been decided that the entire seed intended to be sown in the area declared as infested by the disease would be pelletised with an appropriate fungicide free of cost by the Agricultural Department, Mysore State, and distributed to cultivators for sowing. Experiments were, therefore, conducted in the infested fields at Chennarayapatna and the results of the fungicidal trials are mentioned in this paper.

Numerous workers have previously tried seed treatment with various fungicides for the control of onion smut using methylcellulose as a sticker. Linn and Newhall<sup>6</sup> used Arasan and Tersan for the control of smut with 5% methylcellulose. This treatment was reported

Fischer<sup>4</sup> have used 50% Thiram with 4% methylcellulose as sticker and found that smut was reduced by 30%. Chupp and Sherf<sup>3</sup> also got good control of smut by using Thiram and Flit-406 in equal quantities by weight, using methylcellulose as a sticker.

In the present studies, the fungicides tried were Thiram, Arasan, Flit-406 and P.C.N.B. The seeds were pelletised with Tenac (a Burmah-Shell product) as a sticker. Tenac was selected because various brands of (carboxy) methylcellulose manufactured in India inhibited the germination of onion seeds to a marked extent. Previously Tenac has been used as a sticker with dithiocarbamates by Abeygunawardena<sup>1</sup> in Ceylon for the control of late blight of potato. Experiments were conducted in January 1963, the main growing season for onion in the affected areas. Replicate plantings were made in all cases and the blocks were randomised. For each replication there was one control block. The seeds were pelletised with



FIGS. 1-2. Fig. 1. Untreated onion seeds compared with pelletised. Fig. 2. With Tenac as sticker.

to give good control. Larson and Walker<sup>5</sup> applied Thiram at 1/10 lb. and the smut was reported to have been controlled. Duran and

Tenac 1:1000 c.c., which gave a complete coating on the entire surface of the seed (Fig. 2) as compared with the check (Fig. 1). Two

ounces of onion seeds were mixed well with known concentration of sticker in a litre flask and well shaken. When the seeds were completely moistened, the excess of the solution was drained off. Two ounces by weight of each of the fungicides were added to the flask separately and vigorously shaken so that the seeds were uniformly coated with the fungicide. It was then dried in shade and sown after two days in the field. There was 100% germination in all the treated seeds, when they were sown in the germination box in the laboratory. Periodical observations were made to study the germination of the seeds under field conditions. Data were collected till the crop was three months old, and the determination of the relative efficacy of the treatments in the field was based on the percentage of decrease in the amount of smut infection as compared with control plots (Table I).

TABLE I

Percentage of healthy onion plants compared with control for each treatment by four fungicides replicated four times

Replica tions	Treatments				
	Thiram	Flit 406	P.C.N.B.	Arasan	Control
1	100.0	94.94	99.75	99.43	93.93
2	99.5	99.32	99.08	99.74	93.75
3	100.0	100.0	98.18	99.17	95.37
4	100.0	99.86	99.54	98.98	93.33
Average	99.87	98.53	99.36	99.33	94.09

It can be seen from Table I that the average incidence of smut in control (untreated) was 5.91 whereas it was 0.13, 1.47, 0.64 and 0.67% respectively in treatment with Thiram, Flit-406, P.C.N.B. and Arasan. In view of the superiority of Thiram over others, it will be used for pelleting seeds for distribution to the cultivators by the State Agriculture Department.

It is also of interest to note that, even in the absence of the onion crop since 1960, the smut has survived in the soil for about 2½ years. This is not unusual; the ability of the smut to survive in soil for as long as 15 years in the absence of susceptible host has been reported.<sup>2</sup>

- \*1. Abeygunawardena, D. V. W., *Trop. Agric.*, 1960, **116** (2), 125 [From *Rev. App. Mycol.*, 1962, **41** (4), 246.]
2. Butler, E. J. and Jones, S. G., *Plant Pathology*, MacMillan & Co., Ltd., London, 1949, p. 699.
3. Chupp, C. and Sherf, A. F., *Vegetable Diseases and Their Control*, The Ronald Press Co., New York, 1960, p. 377.
4. Duran, R. and Fischer, G. W., "Efficacy and limitation of hexachlorobenzene for the control of onion smut," *Plant Disease Reporter*, 1959, **43**, 880.
5. Larson, R. H. and Walker, J. C., "Thiram for smut control in onion set plantings," *Phytopath.*, 1953, **43**, 596.
6. Linn, M. B. and Newhall, A. G., "Comparison of two methods of pelleting onion seed in the control of smut," *Ibid.*, 1948, **38**, 218.
7. Venkatakrishnaiah, N. S., "Smut on onion and garlic in Mysore," *Curr. Sci.*, 1960, **29**, 26.

\* Original not seen.

## COHERENTLY DRIVEN MOLECULAR VIBRATIONS AND LIGHT MODULATION

THEORIES of Raman lasers have concentrated attention on the individual molecular processes of Raman scattering and on the normal Raman emission. Very intense light beams in dense matter produce interesting higher-order Raman effects, particularly through excitation of intense coherent molecular oscillations at infrared frequencies. These modulate the original light and its Raman-scattered radiation, producing Raman and anti-Stokes lines of many orders, frequently without a threshold condition for generation, and in some cases with highly directional radiation patterns.

By using what is known as the "giant-pulse" technique laser beams from a ruby laser rod have been known to develop a peak power of 500 million watts per sq. cm. When such a pulsed beam is focussed by a lens on to a Raman-active liquid the molecules of the

illuminated liquid are subject to an oscillating electric field of enormously high intensity. In a recent communication to *Physical Review Letters*, August 15, 1963, Townes *et al.* discuss from theoretical considerations the effect of very intense electric fields on the natural oscillations of radiating molecules and their interaction with the incident radiation. They deduce a number of interesting conclusions.

One of the deductions is that anti-Stokes radiation of frequencies  $\omega_0 + \omega_r$  is emitted in cones in the forward direction around the initial beam at angles determined by the vibration frequency, the polarizability of the molecule and other parameters.

(For an excellent photograph in colour of the Raman laser effect produced in benzene, see *Scientific American*, July 1, 1963.)—(*Physical Rev. Letters*, 1963, **11**, 160.)

## LETTERS TO THE EDITOR

MEAN AMPLITUDES OF VIBRATION  
OF SOME OCTAHEDRAL  $XY_6$  TYPE  
IONS FROM RAMAN DATA

THE  $XY_6$  type molecules and ions possessing the octahedral symmetry with the point group  $O_h$  give, according to the relevant selection rules,<sup>1</sup> a non-degenerate  $A_{1g}$  vibration ( $\nu_1$ ), a degenerate  $E_g$  vibration ( $\nu_2$ ), two triply degenerate  $F_{1u}$  vibrations ( $\nu_3$  and  $\nu_4$ ), a triply degenerate  $F_{2g}$  vibration ( $\nu_5$ ) and a triply degenerate  $F_{2u}$  vibration ( $\nu_6$ ). Heath and Linnett<sup>2</sup> have already given the normal modes of vibration for this type of molecules in which  $\nu_1$ ,  $\nu_2$  and  $\nu_3$  are associated with essentially valence vibrations and  $\nu_4$ ,  $\nu_5$  and  $\nu_6$  with essentially deformation vibrations. The  $A_{1g}$ ,  $E_g$  and  $F_{2g}$  vibrations are Raman active, the first of these is strongly polarized and the remaining are depolarized. The  $F_{1u}$  vibrations are infra-red active and  $F_{2u}$  vibration is inactive both in Raman as well as infra-red spectra.

The mean amplitudes of vibration for several molecules of this type have recently been studied by Sundaram<sup>3</sup> and Nagarajan<sup>4,5</sup> but no ion has been studied so far. No one has so far studied the infra-red spectrum of any ion of this type. The aim of the present investigation is to study the mean amplitudes of vibration at the temperatures  $T = 0$  and  $T = 298^\circ \text{K}$ . from the three Raman frequencies for the hexachloropalladate, hexachloroplatinate, hexabromoplatinate, hexachloroselenate, hexachlorostibate, hexachloroplumbate, hexachlorostannate, hexabromostannate and hexachlorotitanate ions of which the first five having X, an atom of a transition element belong to the A-subgroup and the remaining having X, an atom of a non-transition element belong to the B-subgroup of the periodic table. The bonding in the hexahalide ions of A-subgroup involves  $d^2sp^3$  hybridization (using inner  $d$ -orbitals) whereas the bonding in the hexahalide ions of B-subgroup is of the  $sp^3d^2$  type (using outer  $d$ -orbitals).

The fundamental Raman frequencies in  $\text{cm}^{-1}$  for all the nine ions are given in Table I. Before computing the mean amplitudes of vibration, the force constants on the basis of Wilson's group theoretical method<sup>10</sup> were calculated and their values in millidynes/ $\text{\AA}$  are given in Table II

where  $f_d$  is the force constant due to the X-Y stretching,  $f_{dd}$  the interaction constant between two adjacent X-Y stretchings and  $f$  the force constant due to the bending of the molecule.

TABLE I  
The fundamental Raman frequencies in  $\text{cm}^{-1}$   
for some octahedral  $XY_6$  type ions

Ion	$\nu_1 (A_{1g})$	$\nu_2 (E_g)$	$\nu_5 (F_{2g})$	Reference
$\text{PdCl}_6^{--}$	317	292	164	6
$\text{PtCl}_6^{--}$	344	320	162	6
$\text{PtBr}_6^{--}$	207	190	97	6
$\text{SeCl}_6^{--}$	346	273	166	7
$\text{SbCl}_6^{--}$	337	277	172	7
$\text{PbCl}_6^{--}$	285	215	137	8
$\text{SnCl}_6^{--}$	311	229	158	9
$\text{SnBr}_6^{--}$	195	138	95	9
$\text{TiCl}_6^{--}$	463	40	252	7

TABLE II  
Force constants in millidynes/ $\text{\AA}$  for some  
octahedral  $XY_6$  type ions

Ion	$f_d$	$f_{dd}$	$f_\phi$
$\text{PdCl}_6^{--}$	1.8891	0.0531	0.1406
$\text{PtCl}_6^{--}$	2.2524	0.0556	0.1372
$\text{PtBr}_6^{--}$	1.8090	0.0531	0.1110
$\text{SeCl}_6^{--}$	1.8734	0.1575	0.1441
$\text{SbCl}_6^{--}$	2.3748	1.6044	0.1546
$\text{PbCl}_6^{--}$	1.2106	0.1220	0.0981
$\text{SnCl}_6^{--}$	1.4052	0.1543	0.1305
$\text{SnBr}_6^{--}$	1.1369	0.1193	0.1064
$\text{TiCl}_6^{--}$	3.1057	0.3442	0.3320

Following the methods outlined by Nagarajan<sup>4</sup> for this type of molecules the three symmetrized mean-square amplitude matrices namely  $\Sigma_{11}$ ,  $\Sigma_{22}$  and  $\Sigma_{55}$  were easily evaluated from the three Raman frequencies. From these values three mean-square amplitude quantities in  $\text{\AA}^2$  namely  $\sigma_r$ , the mean-square amplitude quantity due to the bonded atom pair,  $\sigma_{rr}$  the interaction term and  $\sigma_\theta$  the quantity due to the bending of the molecule were evaluated and their values in  $\text{\AA}^2$  are given in Table III at the temperatures  $T = 0$  and  $T = 298^\circ \text{K}$ . respectively. These values were also checked from the obtained force constants of the present study according to the secular equation given by Cyvin.<sup>11</sup> The corresponding mean amplitudes of vibration in  $\text{\AA}$  for the bonded atom pair alone at these temperatures are given in Table IV.

The mean amplitudes of vibration, as expected, are similar in the four hexachloride ions of the A-subgroup for both temperatures.

TABLE III  
Mean-square amplitude quantities in  $\text{\AA}^2$  for some octahedral  $\text{XY}_6$  type ions

Ion	$\sigma_r$		$\sigma_{rr}$		$\sigma_\theta$	
	T=0	T=298° K.	T=0	T=298° K.	T=0	T=298° K.
$\text{PdCl}_6^{--}$	0.0015859	0.0028296	-0.0000214	-0.0000703	0.0115998	0.0479221
$\text{PtCl}_6^{--}$	0.0014516	0.0024069	-0.0000173	-0.0000475	0.0117430	0.0485137
$\text{PtBr}_6^{--}$	0.0010792	0.0029598	-0.0000152	-0.0001889	0.0086945	0.0615788
$\text{SeCl}_6^{--}$	0.0016195	0.0029353	-0.0000613	-0.0001549	0.0114600	0.0473445
$\text{SnCl}_6^{--}$	0.0016049	0.0029168	-0.0000510	-0.0002916	0.0110602	0.0412690
$\text{PbCl}_6^{--}$	0.0020308	0.0042057	-0.0000906	-0.0002906	0.0138858	0.0823233
$\text{SnCl}_6^{--}$	0.0018942	0.0037645	-0.0000913	-0.0002765	0.0120403	0.0497419
$\text{SnBr}_6^{--}$	0.0031545	0.0144492	-0.0001459	-0.0015895	0.0088775	0.0628733
$\text{TiCl}_6^{--}$	0.0012750	0.0019398	-0.0000619	-0.0001585	0.0075490	0.0150512

TABLE IV  
Mean amplitudes of vibration in  $\text{\AA}$  for some octahedral  $\text{XY}_6$  type ions

Ion	Distance	Mean amplitude of vibration	
		T=0	T=298° K.
$\text{PdCl}_6^{--}$	Pd-Cl	0.0398	0.0532
$\text{PtCl}_6^{--}$	Pt-Cl	0.0381	0.0491
$\text{PtBr}_6^{--}$	Pt-Br	0.0318	0.0544
$\text{SeCl}_6^{--}$	Se-Cl	0.0403	0.0542
$\text{SnCl}_6^{--}$	Sb-Cl	0.0401	0.0540
$\text{PbCl}_6^{--}$	Pb-Cl	0.0451	0.0649
$\text{SnCl}_6^{--}$	Sn-Cl	0.0435	0.0614
$\text{SnBr}_6^{--}$	Sn-Br	0.0562	0.1212
$\text{TiCl}_6^{--}$	Ti-Cl	0.0357	0.0441

Similar results are also observed in the hexachloride ions of the B-subgroup but the values are slightly less in the hexachlorotitanate ion for these temperatures. This shows that a reinvestigation of the Raman spectrum of hexachlorotitanate ion is needed. The results of the present investigation would be very useful for the interpretation of the electron diffraction studies.

The author wishes to express his sincere thanks to the Council of Scientific and Industrial Research, Government of India, for the financial assistance by offering a senior research fellowship.

Department of Physics,  
Annammalai University,  
Annammalainagar, South India,  
March 20, 1963.

G. NAGARAJAN.\*

\* Present address: Post doctoral Fellow, Department of Chemistry, University of Maryland, College Park, Maryland, U.S.A.

1. Herzberg, H., *Infra-red and Raman Spectra of Polyatomic Molecules*, D. Van Nostrand Company, Inc., New York, 1945.
2. Heath, D. F. and Linnett, J. W., *Trans. Farad. Soc.*, 1949, **45**, 264.

3. Sundaram, S., *Zeits. f. Physik. Chem. Neue Folge.*, 1962, **34**, 225.
4. Nagarajan, G., *Bull. Soc. Chim. Belg.*, 1963, **72**, 537.
5. —, *Curr. Sci.*, 1963, **32**, 64.
6. Wood, L. A. and Creighton, J. A., *Spectrochimica Acta.*, 1961, **17**, 594.
7. Londolt-Bornstein, *Atom-und Molekularphysik*, Springer-Verlag, Berlin, 1951, Teil 2.
8. Creighton, J. A. and Woodward, L. A., *Trans. Farad. Soc.*, 1962, **58**, 1077.
9. Woodward, L. A. and Anderson, L. E., *J. Chem. Soc.*, 1957, 1284.
10. Wilson, E. B. Jr., *J. Chem. Phys.*, 1939, **7**, 1047; 1941, **9**, 76.
11. Cyvin, S. J., *Acta Polytechnica Scandinavica*, Ph. No. 6 (279/1960), p. 108.

## THERMODYNAMIC PROPERTIES OF CARBON TETRAIODIDE

THE Raman and infra-red spectra of carbon-tetraiodide have been observed and the fundamental frequencies have been assigned on the basis of  $T_d$  symmetry by Stammreich et al.<sup>1</sup> They have calculated the potential constants for the carbontetraiodide molecule by using various types of potential functions and applying Wilson's F-G matrix method. They have obtained a most satisfactory set of force constants with the Urey-Bradley type of potential function. In the present work, the thermodynamic properties such as heat content, heat capacity, free energy and entropy for the carbontetraiodide molecule have been calculated assuming a rigid rotator, harmonic oscillator model. The calculation is for the ideal gas at one atmospheric pressure.

In this calculation the bond distance is taken to be 2.12 Å from the electron diffraction data of Finback and Hassel.<sup>2</sup> The symmetry number used is 12. The calculated principal moments of inertia are  $I_{xx} = I_{yy} = I_{zz} = 1520.5016 \text{ amu } \text{\AA}^2$ . The vibrational contributions to the thermodynamic functions have been calculated using

the Table given by Johnston *et al.*<sup>3</sup> The calculation is made for a temperature range of 100° K. to 1,000° K. and the calculated values of the thermodynamic functions have been presented in Table I.

TABLE I  
Thermodynamic functions of  $Cl_4^*$

Temp. °K.	$(H^\circ - E_0^\circ)/T$	$-(F^\circ - E_0^\circ)/T$	$S_0^\circ$	$C_p^\circ$
100	12.5024	59.0329	71.5353	17.3461
200	15.9140	68.8722	84.7362	20.9338
273.16	17.4819	74.0778	91.5597	22.5141
300	17.9555	75.7439	93.6994	23.9342
400	19.3489	81.1554	100.5043	23.9904
500	20.3417	85.5654	105.9071	24.5898
600	21.0793	89.3070	110.3863	24.9367
700	21.6397	92.5360	114.1757	25.1596
800	22.0962	95.5771	117.6732	25.3089
900	22.4529	98.1604	120.6132	25.4132
1000	22.7404	100.3758	123.1162	25.4897

\* The values are in cal./deg./mole.

The author wishes to thank the Council of Scientific and Industrial Research, Government of India, for the award of a Senior Research Fellowship.

Dept. of Physics, M. RADHAKRISHNAN.  
Annamalai University,  
Annamalainagar, March 18, 1963.

1. Stammreich, H., Tavares, Y. and Bassi, D., *Spec. Chimica Acta*, 1961, **17**, 661.
2. Finbak, C. and Hassel, O., *Z. Physik. Chem. Leipzig*, 1937, **36 B**, 301.
3. Johnston, H. L., Savedoff, L. and Ielzer, J., Office of Naval Research Publication, Washington, 1949.

## CYCLOHEXANE DIAMINE TETRA- ACETIC ACID COMPLEXES

### II. Iron

THE formation constants of the complexes of many rare-earth and heavy metal cations with CDTA have been determined by Schwarzenbach *et al.*<sup>1</sup> from a polarographic study of the exchange equilibria. The iron system is found to be reversible and this note deals with the determination of the stability constants of ferric and ferrous iron complexes from the polarographic and spectrophotometric measurements.

A manual set-up using an H-cell and a saturated calomel electrode as a reference electrode was used for the polarographic measurements. The measurements were made with deaerated solutions at  $30 \pm 0.1^\circ$  C. and with a capillary

having the following characteristics:  $m = 1.33$  mg. sec.<sup>-1</sup> and  $t = 3.7$  sec. (open circuit). Optical densities were measured on a Beckman DU quartz spectrophotometer using 1 cm. cells. A Cambridge Bench Type pH meter was used for measuring the pH of the solutions. Standard solutions of ferric chloride and CDTA<sup>2</sup> were used. Sodium nitrate or sodium perchlorate was used for maintaining the ionic strength constant at 1.0. The pH was adjusted with perchloric acid or sodium hydroxide.

**Polarographic Studies.**—Ferric iron in CDTA medium gave a one-electron reversible reduction wave as indicated by the slope of the log-plots. Table I gives the half-wave potential and slope as a function of pH. In the range of 3 to 8.5, the half-wave potential was independent of both pH and CDTA concentration and was constant at  $-0.129 \pm 0.002$  V vs. S.C.E.

TABLE I  
Effect of pH on half-wave potentials of  
Iron-CDTA system

$FeCl_3 = 1.48$  mM.,  $NaClO_4 = 1$  M.

pH	CDTA M.	$E_{\frac{1}{2}}$ - V vs. S.C.E.	Slope mV	id uA
0.90	0.006	-0.022	58	3.40
1.24	0.006	0.013	64	3.35
2.80	0.006	0.118	60	3.34
3.08	0.006	0.127	60	3.27
3.46	0.006	0.127	60	3.31
4.94	0.006	0.130	57	3.26
5.40	0.02	0.128	59	3.30
6.00	0.04	0.132	55	3.30
7.00	0.04	0.127	59	3.19
8.80	0.04	0.139	58	3.23

The formal oxidation potential for the reaction



at 30° C. and an ionic strength of 1.0 was calculated to be  $+0.112$  V vs. N.H.E. The ratio  $K_{ox}/K_{red}$  of the formation constants of the oxidised system to the reduced system was calculated from the equation

$$(E_{\frac{1}{2}})_c - (E_{\frac{1}{2}})_r = -0.059 \log \left[ \frac{K_{ox}}{K_{red}} \right] \quad (2)$$

to be  $4.57 \times 10^{10}$ , taking the half-wave potential of the simple ion to be equal to  $+0.741$  V vs. N.H.E.<sup>3</sup>

**Spectrophotometric Studies.**—The stability constant of the ferric complex can be represented as<sup>4</sup>

$$K_{ox} = \frac{(FeY)}{(Fe^{+3})(Y^{-4})} \\ = \frac{(FeY^-)(H^+)^3 \left(1 + \frac{H^+}{k_1}\right)}{[C_{Fe} - (FeY^-)] \sum_v k_2 k_3 k_4} \quad (3)$$



TABLE II  
Stability constants of the Ferric-CDTA complex  
Ionic strength = 1.0,  $K_{Ox} = [FeY^-]/[Fe^{3+}][Y^{4-}]$

HClO <sub>4</sub> M.	C <sub>Fe</sub> mM.	C mM.	FeY <sup>-</sup> mM.	C <sub>Fe-FeY</sub> mM.	ΣY	K <sub>Ox</sub> × 10 <sup>-26</sup>
1.00	0.9596	1.562	0.5737	0.2859	0.9883	8.9
1.00	0.9596	0.781	0.3591	0.6005	0.219	8.4
1.00	0.9596	0.9372	0.4132	0.5464	0.5241	8.5
1.00	0.6717	1.562	0.4033	0.2684	1.1587	7.7
1.00	0.4798	1.562	0.315	0.1648	1.247	9.1
0.80	0.9596	1.562	0.7196	0.2400	0.8424	8.6
0.80	0.9596	0.9372	0.5339	0.4057	0.3833	8.6
0.80	0.9596	0.6248	0.4218	0.5378	0.203	9.4
0.60	0.5758	0.4686	0.3335	0.2423	0.1351	7.8
0.60	0.4798	0.4686	0.3085	0.1713	0.1601	8.6
						Ave. 8.5 ± 0.9

where  $\Sigma Y$  which is equal to  $(C_Y - FeY^-)$  represents the total concentration of uncombined CDTA and  $C_{Fe}$  and  $C_Y$  represent the total concentrations of iron and CDTA respectively.  $k_1$  to  $k_4$  are the ionisation constants of CDTA. Knowing the acidity, the total concentrations of iron, CDTA and the concentration of the complex, the formation constant was calculated.

The concentration of the complex,  $FeY^-$  was determined spectrophotometrically. The absorption spectra of ferric CDTA system was studied at pH 4 in 0.01 M. CDTA. Beer's law was found to be obeyed over a concentration range of 0.5 to 2 mM. in the region of 360-400 mμ. The absorption spectra of ferric iron would not interfere in the determination of the complex in this wavelength region. Equilibrium mixtures were prepared from known amounts of ferric iron, CDTA and perchloric acid, keeping the ionic strength at 1.0. Measurements were made at 30 ± 1° C. at 390 and 400 mμ. The results are given in Table II. The formation constant of the ferric complex was calculated to be  $8.5 \times 10^{26}$ .

The ratio  $K_{Ox}/K_{red}$  determined from polarographic measurements was  $4.57 \times 10^{10}$  and so the formation constant of the ferrous complex was calculated to be  $1.86 \times 10^{16}$ .

The authors wish to thank Dr. V. T. Athavale for his kind interest.

Analytical Division,  
Atomic Energy Estab.,  
Trombay, Bombay,  
April 1, 1963.

T. P. RADHAKRISHNAN.  
S. C. SARAIYA.  
A. K. SUNDARAM.

- Schwarzenbach, G., Gut, R. and Anderegg, G., *Helv. Chim. Acta*, 1954, 37, 937.
- Saraiya, S. C. and Sundaram, A. K., *Jour. Sci. Ind. Res.*, 1962, 21, 264.
- Schumb, W. C., Sherrill, M. S. and Sweetser, S. B., *J. Am. Chem. Soc.*, 1937, 59, 2360.

- Kolthoff, I. M. and Auerbach, C., *Ibid.*, 1952, 74, 1452.
- Schwarzenbach, G. and Ackermann, H., *Helv. Chim. Acta*, 1949, 32, 1682.

#### REMARKS ON K-CONVERSION COEFFICIENTS OF E2 TRANSITIONS IN RARE-EARTH NUCLEI

RECENT work of Subba Rao<sup>1</sup> and Ramaswamy<sup>2</sup> on E2 transitions in rare-earth nuclei has pointed to the rather interesting conjecture that there may be a correlation between nuclear deformation and deviations of  $a_K$  from theory. This was reached in spite of the rather large errors in the available data for E2 conversion coefficients.

It is the purpose of this note to emphasize that more accurate values for  $a_K$  for E2 transitions can be obtained for comparison with theory by combining the data on measured half-life, the reduced E2 transition probability determined from inelastic proton scattering experiments and energies accurately determined with a bent crystal spectrometer, which are related by the equation;

$$B(E2) [2^+ - 0^+] = \frac{75\hbar}{4\pi} \left( \frac{\hbar C}{E} \right)^5 \frac{\ln 2}{t_{1/2} (1 + \alpha)} \quad (1)$$

From this an experimental  $a_{\text{expt.}}$  can be deduced. If the assumption is made that no deviations from theory occur for K/L ratios as found by Subba Rao,<sup>1</sup> and further if we take  $a_M + a_N + \dots = 1/3 (a_L)$ , then  $(a_K)_{\text{expt.}}$  can be deduced from the relation:

$$(a_K)_{\text{expt.}} = \frac{a_{\text{expt.}}}{1 + (4/3) a_L/a_K} \quad (2)$$

This can be in turn compared with theory as also with direct determination of  $a_K$  from magnetic spectrometer data. Such a com-

parison is made and shown in Table I. The fourth column is theoretically computed<sup>3</sup>. The fifth column lists the  $(a_K)_{\text{expt.}}$  as deduced from equation (2). The last column gives the values labelled as  $(a_K')_{\text{expt.}}$  and are the conversion coefficients determined from magnetic spectrometer data taken from the compilation of Subba Rao.<sup>1</sup> For  $a_{\text{expt.}}$  the values given in a recent paper by Fossan and Herskind<sup>4</sup> have been used.

Nucleus	Transition Energy (keV)	$a_{\text{expt.}}$ (Ref. 4)	$a_L/a_K$ (Ref. 3)	$(a_K)_{\text{expt.}}$	$(a_K')$ (Ref. 1)
Sm <sup>152</sup>	122	1.26 ±0.1	0.559	0.72 ±0.06	0.7 ±0.1
Gd <sup>154</sup>	123	1.46 ±0.2	0.65	0.78 ±0.11	0.54 ±0.13
Gd <sup>156</sup>	89	4.1 ±0.2	1.171	1.60 ±0.04	..
Dy <sup>160</sup>	84	5.7 ±0.1	1.692	1.75 ±0.12	1.75 ±0.2
Er <sup>164</sup>	91	5.2 ±0.4	1.759	1.55 ±0.12	1.9 ±0.2
Er <sup>166</sup>	81	7.2 ±0.4	2.452	1.69 ±0.09	1.88 ±0.18
Yb <sup>170</sup>	84	7.2 ±0.4	2.878	1.49 ±0.08	1.6 ±0.15
W <sup>182</sup>	100	4.5 ±0.2	2.742	0.97 ±0.04	..

Some interesting facts emerge from this comparison.

1. The  $(a_K)_{\text{expt.}}$  as determined from equation (2), Column 5, in Table I has smaller error than the weighted values of  $(a_K')$  (column six).

2. The two values for  $a_K$  agree within statistics with the possible exception of the 123 keV transition in Gd<sup>154</sup> indicating the need for remeasurement of one of several quantities in equation (1) or  $(a_K')$ .

3. Since recent  $(a_K')$  values as measured by the Internal-External conversion method are by far the most accurate, claiming an accuracy of 3% or better (which might be an underestimate considering the errors that enter into the theoretical calculation of the photoelectric cross-section), it appears as though we have here a good check on the IEC method.

In conclusion, it is to be emphasized that further experimental data on rare-earth transitions are needed to clear up the question of a possible connection between nuclear deformation and deviations of  $a_K$  from theory.

Dept. of Physics, M. K. RAMASWAMY.  
Karnatak University, S. M. BRAHMAVAR.  
Dharwar-3, April 10, 1963.

1. Subba Rao, B. N., *Nuovo Cim.*, 1960, 17, 189.
2. Ramaswamy, M. K., *Ibid.*, 1960, 18, 1287.

3. Pancholi, S. C. and Siddique, D., *Annal. Acad. Reg. Sci. Upsala*, 1962, 6, 59.
4. Fossan, D. B. and Herskind, B., *Nucl. Phys.*, 1963, 40, 24.

### ON THE NATURE OF OPTIMAL PROPERTIES OF THE LIKELIHOOD RATIO CRITERION TEST PROCEDURE

THOUGH the likelihood ratio criterion test (l.r.c.t.) procedure for testing a null hypothesis  $H_0$  by choosing the critical region (C.R.) as

$$\frac{L(\Omega_{\text{max.}})}{L(\omega_{\text{max.}})} \geq \text{a suitable constant}$$

has the definite advantage of being unique in spite of the absence of any alternative hypothesis, and though it is known to possess some desirable features in many situations, yet the exact nature of the optimal properties have to be determined in any particular application of the method. This is due to two reasons. Firstly, the result that, if a uniformly most powerful test (U.M.P.T.) exists for all alternatives, the C.R. constructed by the l.r.c.t. procedure coincides with it, is of very limited application, because a U.M.P.T. exists rarely. Secondly, the 'average best' nature of the l.r.c.t. is too limited in the scope of its applicability.

In this note the authors have examined the nature of the optimal properties of the l.r.c.t. in following two particular cases of a normal population:

1. The standard deviation  $\sigma$  is known, but the mean is not known. The null hypothesis set-up is  $H_0: m = m_0$ . There is no alternative hypothesis. It is required to draw a random sample  $O_n: (x_1 \dots x_n)$  and test  $H_0$  at a given level of significance  $\alpha$ .
2. The standard deviation is not known. The null hypothesis is  $H_0: \sigma = \sigma_0$ . There is no alternative hypothesis. It is required to test  $H_0$  at  $\alpha$ -level of significance by drawing a random sample  $O_n: (x_1 \dots x_n)$ .

In the first case, two test procedures suggest themselves, viz., (a) with C.R. given by

$$\left| \frac{\bar{x} - m_0}{\sigma/\sqrt{n}} \right| \geq A,$$

and (b) with C.R. given by

$$\frac{\sum_{i=1}^n (x_i - m_0)^2}{\sigma^2} \geq B.$$

The former is also the l.r.c.t., and hence a comparison of these tests becomes a comparison of

the L.R.C.T. with the right-tail-end of chi-square tests.

Now, the power curves of both C.R.'s are symmetrical about the vertical line through  $m_0$ . It is also known that the L.R.C.T. here is unbiased and locally most powerful (i.e., Type A region). Some calculations based on non-central chi-square distribution<sup>3</sup> show that when  $m$  is sufficiently large, whatever be  $m_0$ , the power of the L.R.C.T. is greater than the power of the other test. Using these considerations, the authors have shown that the L.R.C.T. in this case has the optimal property of being uniformly more powerful than the other test.

Next, coming to the second case where  $H_0: \sigma: \sigma_0$  is to be tested, we note that two cases arise, viz., when  $m$  is known, say  $m_0$ , and  $m$  is not known. When  $m$  is known to be  $m_0$ , we use equal tail-ends of the variate,

$$S^2 = \frac{\sum_{i=1}^n (x_i - m_0)^2}{\sigma_0^2}$$

which is chi-square distributed with  $n$  degrees of freedom on  $H_0$ . But this intuitional procedure can be bettered by choosing the C.R. as Type A region. By a change of origin, we may consider the case where  $m = 0$ . Then if  $(v_1, r_1)$  and  $(v_2, r_2)$  form the Type A C.R., we know<sup>1</sup> that

$$v_1^{n/2} \cdot e^{-v_1/2} = v_2^{n/2} \cdot e^{-(v_2/2)}.$$

The L.R.C.T. gives the C.R. in this case by the condition:

$$S^2 / \sigma_0^2 = \log \frac{S^2}{\sigma_0^2} = \text{constant}.$$

The authors have shown the equivalence of the two C.R.'s so that the optimal property of the L.R.C.T. in this case can be explicitly stated as giving a Type A C.R. Even when  $m$  is not known, the L.R.C.T. procedure can be seen to possess the same optimal property of leading to Type A region.

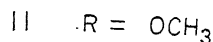
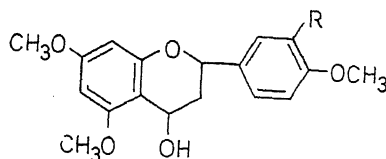
We thank Prof. K. Nagabhushanam for his help and suggestions in doing this work.

Andhra University, C. S. K. BHAGAVAN.  
Waltair, June 17, 1963. K. V. SURYANARAYANA.

1. Kendall, M. G., *Advanced Theory of Statistics*, Vol. 2, 2nd Edition, p. 312.
2. Roy, S. N., "Univariate and multivariate analysis as problems in testing of composite hypothesis—I," *Sankhya*, 1950, **10**, 29.
3. Patnaik, P. B., "The non-central chi-square and F-distributions and their applications," *Biometrika*, 1949, **36**, 202.

## A SPECIAL CHARACTERISTIC OF 5-METHOXYFLAVAN-4-OLS

RECENT publications<sup>1-3</sup> on the preparation of flavan-4-ols and study of their configurations prompt us to report some of our observations made quite some time ago. Two stereoisomeric 4-hydroxyflavans (designated  $\alpha$  and  $\beta$ ) are possible. Bogner *et al.*<sup>2</sup> summarised the different methods used for their preparation. With the revised configurations of the flavan-4-ols<sup>5,6</sup> reduction of a flavanone using (i) Al/Hg and ethanol<sup>4</sup> and (ii) the oxime-amine-hydroxyl method is considered to give 2,4-*trans* racemate and (iii) metal hydrides and (iv)  $H_2/P_t$  to give 2,4-*cis* racemate. The cases where both the isomeric alcohols have been obtained<sup>2</sup> are (1) 4-hydroxy, (2) 6-chloro, (3) 4'-methoxy and (4) 4'-methoxy-6-methyl-4-hydroxyflavans. In addition Row and co-workers<sup>3</sup> prepared a few 6-methoxyflavan-4  $\beta$ -ols. All these flavan-4-ols which are devoid of 5-hydroxyl or methoxyl, are known to give distinct acetates.<sup>2,3</sup> We had occasion to prepare 5,7,4'-trimethoxyflavan-4  $\beta$ -ol (I)<sup>7</sup> and 5,7,3',4'-tetramethoxyflavan-4  $\beta$ -ol (II)<sup>7</sup> and these have shown certain unexpected properties; it appears that the 5-methoxyl may be the cause.



The trimethoxyflavan-4-ol (I), m.p. 159°, on treatment with acetic anhydride and pyridine at room temperature for 48 hours, gave a substance as colourless needles, m.p. 116-117°. This was different from the acetate of I which was earlier reported by Geissman and Clinton<sup>8</sup> as having an m.p. 129°. Since neither their sample nor the details of the procedure were available (private communication from Prof. Geissman) a closer study of our product m.p. 116-117° was made. In composition, U.V. ( $\lambda_{\max}$ , 272 m $\mu$ ,  $\log \epsilon$  3.38,  $\lambda_{\min}$ , 255 m $\mu$ ,  $\log \epsilon$  3.18) and I.R. (main bands: 2.79, 6.21, 6.36, 6.74 and 6.88  $\mu$ ) spectra and colour test with conc. HCl the substance very closely resembles I. From these data it is evident that the new substance is isomeric with I. It is therefore

possible it might be the  $\alpha$ -compound. To confirm this, attempts have been made to obtain this  $\alpha$ -racemate starting from 5, 7, 4'-trimethoxyflavanone by using the methods (i) and (ii). However, method (i) yielded a product from which only the flavpinacol (m.p.  $204^\circ$ ) could be isolated as the chief component. The method (ii) also did not proceed satisfactorily. A comparison of the NMR spectra of the new substance and of I indicates that they are stereoisomeric. We, therefore, tentatively regard this substance to be the 5, 7, 4'-trimethoxyflavan-4  $\alpha$ -ol. If this is correct the concerned reaction has brought about epimerisation at carbon-4. Likewise, 5, 7, 3', 4'-tetramethoxyflavan-4  $\beta$ -ol (II), m.p.  $114^\circ$ , gave a product m.p.  $89^\circ$  isomeric with II.

Treatment of I with sodium acetate and acetic anhydride in the cold did not effect acetylation and the compound was recovered; while heating at  $100^\circ$  led to dehydration. The details will be published later on.

The above-mentioned failure of the 4-ols to form acetates under the usual conditions is considered to be due to the 5-methoxyl exerting steric influence. Using Buchi models, the configuration of flavan-4-ols has been examined. In the "sofa" conformation of the chroman ring<sup>9</sup> which is considered to be the preferred form, the distance between the oxygen atoms on carbon-4 (axial or equatorial) and 5 is only 2.8 Å which is insufficient for the free approach of the reagent. Under the mild conditions used (cold acetylation) acetylium cation is not therefore able to reach the site of action. On the other hand energetic conditions (hot acetylation) seems to favour dehydration which is fairly facile in flavan-3, 4-diols. However, epimerisation at carbon-4 would require explanation.

The authors wish to acknowledge the help of Dr. D. H. S. Horn, Organic Division, C.S.I.R.O., Melbourne, who has taken the NMR spectra of the two flavan-4-ols.

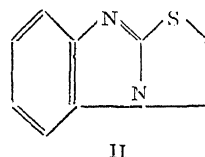
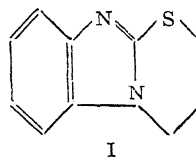
Department of Chemistry, H. G. KRISHNAMURTY.  
University of Delhi, K. G. SARMA.  
Delhi-6, September 6, 1963. T. R. SESHADRI.

1. Kashikar, M. D. and Kulkarni, A. B., *J. Sci. Ind. Res.*, 1954, **18 B**, 418.
2. Bognar, R., Rakosi, M., Fletcher, H., Kehoe, D., Philbin, E. M. and Wheeler, T. S., *Tetrahedron*, 1962, **18**, 135.
3. Row, L. R., Sastry, G. P., Rao, P. V. S. and Rao, M. G., *Curr. Sci.*, 1962, **31**, 459.
4. Freudenberg, K. and Orthner, L., *Ber.*, 1922, **55**, 1748.

5. Clark-Lewis, J. W., Spotswood, T. M. and Williams, L. R., *Austr. J. Chem.*, 1963, **16**, 107.
6. Lillya, C. P., Kehoe, D., Philbin, E. M., Vickars, M. A. and Wheeler, T. S., *Chem. and Ind.*, 1963, **2**, 84.
7. Krishnamurty, H. G., Krishnamurty, V. and Seshadri, T. R., *Phytochemistry*, 1962, **2**, 47.
8. Geissman, T. A. and Clinton, R. O., *J. Amer. Chem. Soc.*, 1946, **68**, 706.
9. Philbin, E. M. and Wheeler, T. S., *Proc. Chem. Soc.*, 1958, 167.

## PERHYDRO THIAZINO- AND THIAZOLO-BENZIMIDAZOLES

THE parent compounds of the heterocyclic systems perhydrothiazino [3, 2-a] benzimidazole (I) and perhydrothiazolo [3, 2-a] benzimidazole (II) have not been reported, though several substituted derivatives are known; e.g., Misra<sup>1</sup> has prepared the 4-oxo-substituted product of (I), and deStevens and Halamandaris have obtained the 2,3-dimethyl derivative of (II).<sup>2</sup>



The perhydro compounds, 2, 3, 4-trihydrothiazino [3, 2-a] benzimidazole (I), m.p.  $138-39^\circ$ , and 2, 3-dihydrothiazolo [3, 2-a] benzimidazole (II), m.p.  $141-42^\circ$ , were synthesised by an elegant process of condensing 2-mercaptobenzimidazole with 1, 3-bromochloropropane and 1, 2-dichloroethane respectively.<sup>3</sup>

2, 3, 4-Trihydrothiazino [3, 2-a] benzimidazole (I).—To a stirred refluxing mixture of 1, 3-bromochloropropane (15 ml.), isopropanol (100 ml.) and sodium bicarbonate (13.6 g.) was added a stirred mixture of 2-mercaptobenzimidazole (5 g.), 20% aqueous potassium hydroxide solution (15 ml.) and isopropanol (85 ml.) over a period of 1 hour. After a further 3 hours of refluxing, the solvent was distilled off completely. 15% Potassium hydroxide (30 ml.) was added to the cooled, dry residue and then the mixture was extracted with chloroform. The chloroform phase was washed with dilute alkali and water, and the solvent removed. The residual product was crystallised, first from aqueous methanol, and then from benzene-light petroleum ( $60-80^\circ$ ), when 2, 3, 4-trihydrothiazino [3, 2-a] benzimidazole was obtained as a fine white powder, m.p.  $138-39^\circ$ . Found: N, 14.2; Calc. for  $C_{10}H_{10}N_2S$ : N, 14.7%.

The picrate prepared by the normal procedure melted at 242-44° (dec.). Found: N, 16.8; Calc. for  $C_{16}H_{13}N_5O_7S$ : N, 16.7%.

2, 3-Dihydrothiazolo [3, 2-a] benzimidazole (II) was prepared in a similar manner from 2-mercaptobenzothiazole and 1, 2-dichloroethane, m.p. 141-42°. Found: N, 16.3; Calc. for  $C_{10}H_8N_2S$ : N, 15.9%. The methiodide melted at 185-87° (dec.). Found: N, 8.9; Calc. for  $C_{12}H_{11}N_2IS$ , 8.8%.

Research and Development      S. L. MUKHERJEE.  
Division,                              G. BAGAVANT.  
Sarabhai Chemicals,                V. S. DIGHE.  
Baroda, August 27, 1963.          S. SOMASEKHARA.

1. Misra, A. L., *J. Org. Chem.*, 1958, **23**, 897 (*Chem. Abstr.*, 1959, **53**, 1353).
2. deStevens, G. and Halamandaris, A., *J. Amer. Chem. Soc.*, 1957, **79**, 5711.
3. Howard, J. C. and Klein, G., *J. Org. Chem.*, 1962, **27**, 3701.

#### DALBERGENONE FROM THE HEARTWOOD OF *DALBERGIA SISSOO*

In an earlier paper<sup>1</sup> the heartwood of *Dalbergia sissoo* was shown to contain dalbergin and O-methyldalbergin. In view of the recent isolation of the quinones, dalbergenone<sup>2</sup> (dalbergione<sup>3</sup>) 4"-methoxy dalbergenone<sup>3</sup> and 4"-hydroxy dalbergenone<sup>3</sup> from the heartwood of *D. latifolia*<sup>2</sup> and *D. nigra*,<sup>3</sup> the heartwood of *D. sissoo* has now been reinvestigated and found to contain dalbergenone in appreciable quantities. Shavings of the heartwood (2.1 kg.) were extracted (soxhlet) with petroleum ether (b.p. 60-80°; 3 x 12 hrs.). The concentrated extract (2.5 l.) on leaving in the refrigerator deposited dalbergenone (5.0 g.) as yellow needles (petroleum ether), m.p. 115-16° C. It gave deep blue colour with alcoholic potassium hydroxide. Subsequent extraction of the shavings with benzene and alcohol and working up the extracts as described earlier<sup>1</sup> gave dalbergin (13.0 g.) and O-methyl dalbergin (2.1 g.).

The association of these 4-phenyl coumarins with dalbergenone emphasises again their relationship in biogenesis as discussed earlier.<sup>4</sup>

Dept. of Chemistry,                V. K. AHLUWALIA.  
University of Delhi,                T. R. SESHADRI.  
Delhi-6, October 3, 1963.

1. Ahluwalia and Seshadri, *J. Chem. Soc.*, 1957, p. 970.
2. Rao and Seshadri, *Tetrahedron Letters*, 1963, p. 211.
3. Eytan, Ollis, Southerland, Jackman, Gottlieb and Magalhaes, *Proc. Chem. Soc.*, 1962, p. 301.
4. Seshadri, *Jour. Indian Chem. Soc.*, 1963, p. 497.

#### ON THE PHARMACOLOGY OF *A. CATECHU* LINN. (N.O. PALMAE)

(Syn.: Pooga, Betel-Nut Palm, Supari, Adike)

##### The Influence of *Areca catechu* Extract on the Vasoconstrictor Action of Adrenalin

VASOCONSTRICTOR effects of some extracts of *A. catechu* have been described earlier.<sup>1</sup> It was also suggested that these actions may be due to the polyphenolic constituents of the nut. Since many polyphenols are known to potentiate the actions of adrenalin *in vivo*,<sup>2</sup> the influence of areca extract on adrenalin-induced vasoconstriction has been studied.

The water extract which was a less active constrictor than the alkali and alcohol extracts was used for the study. The method of preparation of the extract has been described earlier.<sup>1</sup>

The rat hind limb preparation, perfused with oxygenated Ringer's solution, was the technique used to study the effect of drugs individually and in combination.

After the perfusion rate with Ringer's solution was stabilized, Ringer's with adrenalin hydrochloride 1/1000, was perfused continuously. When the outflow was steady, the required doses of the areca extracts were injected and the effects observed.

TABLE I  
The influence of areca extract on adrenalin

Extract	Reduction in vol. %	Remarks
<i>A. catechu</i> water extract 200 µg.	14	Gradual reduction
Adrenalin 1/1000	10	Maintained for over 20 mins.
Adrenalin + water extract of areca 200 µg.	100	An immediate reduction of 80% in 5 mins. Com- plete block for about 5 mins. Gradual recovery to about 60% of the original after $\frac{1}{2}$ hour.
Adrenalin + water extract 50 µg.	80	Recovery to initial value in 20 mins.
Adrenalin + water extract 20 µg.	45	Recovery in 10 mins.

A representative datum of one experiment depicting the extent and duration of vasoconstriction by adrenalin is shown in Fig. 1 and Table I. With slight quantitative variations,

possible it might be the  $\alpha$ -compound. To confirm this, attempts have been made to obtain this  $\alpha$ -racemate starting from 5,7,4'-trimethoxyflavanone by using the methods (i) and (ii). However, method (i) yielded a product from which only the flavpinacol (m.p. 204°) could be isolated as the chief component. The method (ii) also did not proceed satisfactorily. A comparison of the NMR spectra of the new substance and of I indicates that they are stereoisomeric. We, therefore, tentatively regard this substance to be the 5,7,4'-trimethoxyflavan-4  $\alpha$ -ol. If this is correct the concerned reaction has brought about epimerisation at carbon-4. Likewise, 5,7,3',4'-tetramethoxyflavan-4  $\beta$ -ol (II), m.p. 114°, gave a product m.p. 89° isomeric with II.

Treatment of I with sodium acetate and acetic anhydride in the cold did not effect acetylation and the compound was recovered; while heating at 100° led to dehydration. The details will be published later on.

The above-mentioned failure of the 4-ols to form acetates under the usual conditions is considered to be due to the 5-methoxyl exerting steric influence. Using Buchi models, the configuration of flavan-4-ols has been examined. In the "sofa" conformation of the chroman ring<sup>9</sup> which is considered to be the preferred form, the distance between the oxygen atoms on carbon-4 (axial or equatorial) and 5 is only 2.8 Å which is insufficient for the free approach of the reagent. Under the mild conditions used (cold acetylation) acylium cation is not therefore able to reach the site of action. On the other hand energetic conditions (hot acetylation) seems to favour dehydration which is fairly facile in flavan-3,4-diols. However, epimerisation at carbon-4 would require explanation.

The authors wish to acknowledge the help of Dr. D. H. S. Horn, Organic Division, C.S.I.R.O., Melbourne, who has taken the NMR spectra of the two flavan-4-ols.

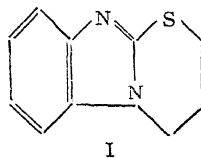
Department of Chemistry, H. G. KRISHNAMURTY.  
University of Delhi, K. G. SARMA.  
Delhi-6, September 6, 1963. T. R. SESHADRI.

1. Kashikar, M. D. and Kulkarni, A. B., *J. Sci. Ind. Res.*, 1954, **18 B**, 418.
2. Bognar, R., Rakosi, M., Fletcher, H., Kehoe, D., Philbin, E. M. and Wheeler, T. S., *Tetrahedron*, 1962, **18**, 135.
3. Row, L. R., Sastry, G. P., Rao, P. V. S. and Rao, M. G., *Curr. Sci.*, 1962, **31**, 459.
4. Freudenberg, K. and Orthner, L., *Ber.*, 1922, **55**, 1748.

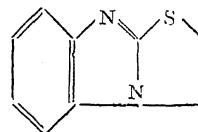
5. Clark-Lewis, J. W., Spotswood, T. M. and Williams, L. R., *Austr. J. Chem.*, 1963, **16**, 107.
6. Lillya, C. P., Kehoe, D., Philbin, E. M., Vickars, M. A. and Wheeler, T. S., *Chem. and Ind.*, 1963, **2**, 84.
7. Krishnamurty, H. G., Krishnamurty, V. and Seshadri, T. R., *Phytochemistry*, 1962, **2**, 47.
8. Geissman, T. A. and Clinton, R. O., *J. Amer. Chem. Soc.*, 1946, **68**, 706.
9. Philbin, E. M. and Wheeler, T. S., *Proc. Chem. Soc.*, 1958, 167.

## PERHYDRO THIAZINO- AND THIAZOLO-BENZIMIDAZOLES

THE parent compounds of the heterocyclic systems perhydrothiazino [3,2-*a*] benzimidazole (I) and perhydrothiazolo [3,2-*a*] benzimidazole (II) have not been reported, though several substituted derivatives are known; e.g., Misra<sup>1</sup> has prepared the 4-oxo-substituted product of (I), and deStevens and Halamandaris have obtained the 2,3-dimethyl derivative of (II).<sup>2</sup>



I



II

The perhydro compounds, 2,3,4-trihydrothiazino [3,2-*a*] benzimidazole (I), m.p. 138–39°, and 2,3-dihydrothiazolo [3,2-*a*] benzimidazole (II), m.p. 141–42°, were synthesised by an elegant process of condensing 2-mercaptobenzimidazole with 1,3-bromochloropropane and 1,2-dichloroethane respectively.<sup>3</sup>

2,3,4-Trihydrothiazino [3,2-*a*] benzimidazole (I).—To a stirred refluxing mixture of 1,3-bromochloropropane (15 ml.), isopropanol (100 ml.) and sodium bicarbonate (13.6 g.) was added a stirred mixture of 2-mercaptobenzimidazole (5 g.), 20% aqueous potassium hydroxide solution (15 ml.) and isopropanol (85 ml.) over a period of 1 hour. After a further 3 hours of refluxing, the solvent was distilled off completely. 15% Potassium hydroxide (30 ml.) was added to the cooled, dry residue and then the mixture was extracted with chloroform. The chloroform phase was washed with dilute alkali and water, and the solvent removed. The residual product was crystallised, first from aqueous methanol, and then from benzene-light petroleum (60–80°), when 2,3,4-trihydrothiazino [3,2-*a*] benzimidazole was obtained as a fine white powder, m.p. 138–39°. Found: N, 14.2; Calc. for C<sub>10</sub>H<sub>10</sub>N<sub>2</sub>S: N, 14.7%.

The picrate prepared by the normal procedure melted at 242-44° (dec.). Found: N, 16.8; Calc. for  $C_{16}H_{13}N_5O_7S$ : N, 16.7%.

2,3-Dihydrothiazolo [3,2-a] benzimidazole (II) was prepared in a similar manner from 2-mercaptobenzothiazole and 1,2-dichloroethane, m.p. 141-42°. Found: N, 16.3; Calc. for  $C_9H_7N_2S$ : N, 15.9%. The methiodide melted at 185-87° (dec.). Found: N, 8.9; Calc. for  $C_{10}H_{11}N_2IS$ , 8.8%.

Research and Development S. L. MUKHERJEE.  
Division, G. BAGAVANT.  
Sarabhai Chemicals, V. S. DICHE.  
Baroda, August 27, 1963. S. SOMASEKHARA.

1. Misra, A. L., *J. Org. Chem.*, 1958, **23**, 897 (*Chem. Abstr.*, 1959, **53**, 1353).
2. deStevens, G. and Halamandaris, A., *J. Amer. Chem. Soc.*, 1957, **79**, 5711.
3. Howard, J. C. and Klein, G., *J. Org. Chem.*, 1962, **27**, 3701.

#### DALBERGENONE FROM THE HEARTWOOD OF *DALBERGIA SISSOO*

In an earlier paper<sup>1</sup> the heartwood of *Dalbergia sissoo* was shown to contain dalbergin and O-methyldalbergin. In view of the recent isolation of the quinones, dalbergenone<sup>2</sup> (dalbergione<sup>3</sup>) 4"-methoxy dalbergenone<sup>3</sup> and 4"-hydroxy dalbergenone<sup>3</sup> from the heartwood of *D. latifolia*<sup>2</sup> and *D. nigra*,<sup>3</sup> the heartwood of *D. sissoo* has now been reinvestigated and found to contain dalbergenone in appreciable quantities. Shavings of the heartwood (2.1 kg.) were extracted (soxhlet) with petroleum ether (b.p. 60-80°; 3-12 hrs.). The concentrated extract (2.5 l.) on leaving in the refrigerator deposited dalbergenone (5.0 g.) as yellow needles (petroleum ether), m.p. 115-16° C. It gave deep blue colour with alcoholic potassium hydroxide. Subsequent extraction of the shavings with benzene and alcohol and working up the extracts as described earlier<sup>1</sup> gave dalbergin (13.0 g.) and O-methyl dalbergin (2.1 g.).

The association of these 4-phenyl coumarins with dalbergenone emphasises again their relationship in biogenesis as discussed earlier.<sup>4</sup>

Dept. of Chemistry, V. K. AHLUWALIA.  
University of Delhi, T. R. SESHADRI.  
Delhi-6, October 3, 1963.

1. Ahluwalia and Seshadri, *J. Chem. Soc.*, 1957, p. 970.
2. Rao and Seshadri, *Tetrahedron Letters*, 1963, p. 211.
3. Eyton, Ollis, Southerland, Jackman, Gottlieb and Magalhaes, *Proc. Chem. Soc.*, 1962, p. 301.
4. Seshadri, *Jour. Indian Chem. Soc.*, 1963, p. 497.

#### ON THE PHARMACOLOGY OF *A. CATECHU* LINN. (N.O. PALMAE)

(Syn.: Pooga, Betel-Nut Palm, Supari, Adike)  
The Influence of *Areca catechu* Extract on the  
Vasoconstrictor Action of Adrenalin

VASOCONSTRICTOR effects of some extracts of *A. catechu* have been described earlier.<sup>1</sup> It was also suggested that these actions may be due to the polyphenolic constituents of the nut. Since many polyphenols are known to potentiate the actions of adrenalin *in vivo*,<sup>2</sup> the influence of areca extract on adrenalin-induced vasoconstriction has been studied.

The water extract which was a less active constrictor than the alkali and alcohol extracts was used for the study. The method of preparation of the extract has been described earlier.<sup>1</sup>

The rat hind limb preparation, perfused with oxygenated Ringer's solution, was the technique used to study the effect of drugs individually and in combination.

After the perfusion rate with Ringer's solution was stabilized, Ringer's with adrenalin hydrochloride 1/1000, was perfused continuously. When the outflow was steady, the required doses of the areca extracts were injected and the effects observed.

TABLE I  
The influence of areca extract on adrenalin

Extract	Reduction in vol. %	Remarks
<i>A. catechu</i> water extract 200 µg.	14	Gradual reduction
Adrenalin 1/1000	10	Maintained for over 20 mins.
Adrenalin + water extract of areca 200 µg.	100	An immediate reduction of 80% in 5 mins. Complete block for about 5 mins. Gradual recovery to about 60% of the original after ½ hour.
Adrenalin + water extract 50 µg.	80	Recovery to initial value in 20 mins.
Adrenalin + water extract 20 µg.	45	Recovery in 10 mins.

A representative datum of one experiment depicting the extent and duration of vasoconstriction by adrenalin is shown in Fig. 1 and Table I. With slight quantitative variations,

the trend of the results was the same in other five experiments.

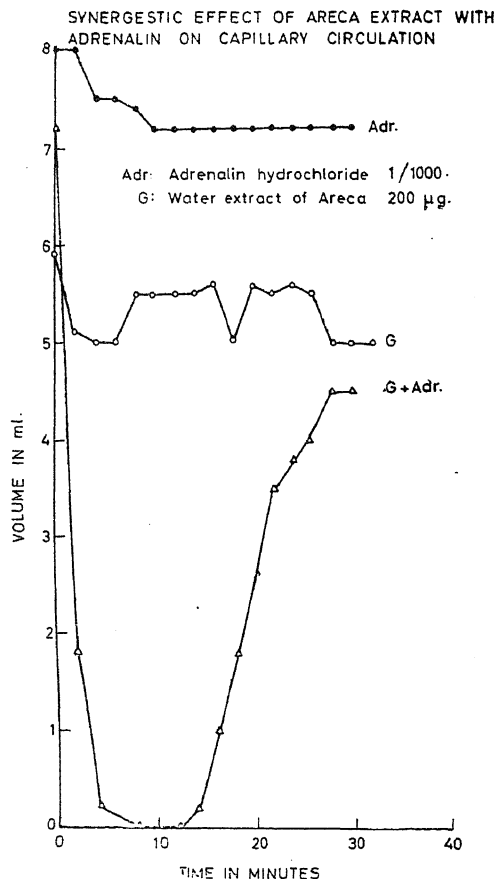


FIG. 1

It is clearly seen that adrenalin action is potentiated by the water extract of arecanut both in intensity and duration. Administration of small doses of areca extract during the recovery phase again caused vasoconstriction. 200 µg. of areca extract and 1/1000 adrenalin individually reduced the outflow by 14% and 10% respectively. Complete blockage of flow within 10 mins., and a gradual recovery to about 60% of the original, after half an hour, was the combined effect of the drugs. The effect is thus seen to be not merely additive, but one of potentiation.

Unlike some polyphenols, which potentiate the effects of adrenalin but exert no action of their own,<sup>2</sup> areca extract exhibits both direct vasoconstrictor action and also adrenalin potentiation.

The extent to which these potent pharmacological properties are likely to influence the vasomotor reactions in health and disease needs elucidation, since arecanut is consumed daily by a vast majority of the population in India and South-East Asia.

The constant encouragement given by Dr. V. Subramanyam, Director, C.F.T.R.I., Mysore, during the course of the investigations and the assistance of Sri. A. G. Mathew in the preparation of the extracts are gratefully acknowledged.

Pharmacology Lab.,

Indian Institute of Sci.,

Bangalore-12,

May 2, 1963.

M. SIRSI.

A. K. DORLE.

V. S. GOVINDARAJAN.\*

\* Present address : Arecanut Officer, Central Food Technological Research Institute, Mysore.

1. Sirsi. M., Dorle, A. K. and Govindarajan, V. S., *The Licentiate*, 1963, **13**, 22.
2. Lavollay, T. and Neumann, J., *The Pharmacology of Plant Phenolics*, Ed. J. W. Fairbairn, Academic Press, London, 1959, p. 103.

#### ANTHELMINTIC PRINCIPLE OF THE SEEDS OF *BUTEA FRONDOSA*—ISOLATION OF AN ACTIVE FRACTION

THE seeds of *Butea frondosa* (Sanskrit—*Palas*) have been reported to be very effective in roundworm infection in indigenous systems of medicine.<sup>1</sup> Clinical trials<sup>2</sup> with the extract of the seeds have confirmed these reports. An attempt was therefore made to investigate the anthelmintic principle present in the seeds.

The presence of three alkaloids in traces, two of which are water-soluble, has been reported in the seeds recently.<sup>3</sup> The present note deals with the isolation of an active fraction from the seeds, its anthelmintic action and toxicity.

Systematic chemical fractionation of the seeds involving extraction of the seeds with petroleum ether (B.P. 40-60°), ether, alcohol and water successively showed that most of the anthelmintic activity was associated with the fraction obtained from the ether extract, although slight activity was also present in the alcohol extract. Powder of fresh fully ripe seeds, defatted with petroleum ether (B.P. 40-60°) was extracted with ether. The ether extract, after concentration, was extracted repeatedly with water. The aqueous extract on removal of solvent in vacuum at 40-45° gave a reddish-brown semi-solid, which was then digested with cold alcohol. The alcoholic solution after removing the in-



soluble matter was evaporated to dryness in vacuum at room temperature and the material redissolved in water. The aqueous solution was purified by extraction with ether after adjusting the pH to 7.5 at 0°, followed by re-extraction with ether after bringing the pH to 4.5 to 5.0. Finally the aqueous solution at pH 7.0 was concentrated in vacuum over phosphorus pentoxide, when a low melting crystalline material was obtained.

The anthelmintic activity of the material was tested<sup>1</sup> and compared with pure piperazine citrate.

The material appears to be slightly more active than piperazine citrate. The activity of the material against live round-worms was also tested. The worms were suspended in modified Tyrode solution containing varying concentration of the material. Controls without the anthelmintic were also run. The worms in the test showed initial stimulatory movements for 1-2 hr. and then paralysis was observed. Mortality was noted at a minimum concentration of 2 mg./c.c. Piperazine citrate also showed similar action at 3 mg./c.c.

The toxicity of the active fraction was studied in mice (20-25 g.). The substance dissolved in 1% glucose solution was given orally and up to 1,000 mg./kg. was tolerated without any toxic symptoms.

The material contains nitrogen and gives a violet red colour with concentrated sulphuric acid. An immediate green colouration was observed with ferric chloride. It may probably be a phenolic compound containing nitrogen.

Thanks are due to the Indian Council of Medical Research, New Delhi, for financing this work.

Division of Biochemistry,  
University of Kerala,  
Trivandrum, April 25, 1963.

R. KALEYSARAJ.  
P. A. KURUP.

1. Nadkarni, A. K., *Indian Materia Medica*, 3rd Ed., Dootapapeshwar Prakasha Ltd., Bombay, 1954, p. 224.
2. *Unpublished Report from Central Institute of Research in Indigenous System of Medicine*, Jamnagar.
3. Kaleysaraj, R. and Kurup, P. A., *Ind. Jour. Pharm.*, 1962, 24 (3), 63.
4. Krishna Kumari, M. K. and Mujumdar, D. K., *J. Sci. Ind. Research (India)*, 1960, 19 B, 206.

## STUDIES ON BOMBAY RATS

### Reduction of Fleas by Bait Boxes

MACCHIAVELO<sup>4</sup> AND POLLITZER<sup>7</sup> recommended the use of DDT powder to control fleas. The Plague Advisory Committee of W.H.O. then recommended this as an antiplague measure, and the same has been used in India.

Reports<sup>8</sup> of plague have come from the Kolar area of Mysore State in 1932. There was also a report of 150 fleas found by C.D.C.A. workers on one *B. bengalensis* collected in this area. This number of fleas indicates a high incidence of pulicidal ectoparasitism in the area. The rat fall observed by the author in March 1963<sup>8</sup> at Kajakahalli was *R. rattus*, where, by pyrethrum spraying a large number of moribund fleas were recovered from the same house. The village houses were said to have been sprayed with conventional insecticides, but at Laxmisagar the author found that the villagers were breeding silkworm in the houses and consequently resented spraying. It will thus be noted that the incidence of fleas was high, while the local pulicidal methods were resented.

Kartmar *et al.*<sup>2</sup> had used bait boxes in fields to control rats and had incorporated pulicides in them. Recently experiments were done at this Institute with wooden bait boxes designed to be used for poison baits in houses to control rats. The keeping of these boxes in houses is not resented by the villagers and it was needed to be seen whether the incorporation of an insecticide in the boxes could reduce the incidence of fleas in the houses that pose a problem during an epidemic.

The bait box used is shown in Fig. 1. The insecticides used were DDT 10% and BHC 5% powder purchased from the market and 0.04% pyrethrum powder made in the laboratory by incorporating the requisite quantity of pyrethrum solution in talc and running this into an improvised small ball mill.

Before making the pyrethrum powder by mixing this solution in talcum, tests were done to see the residual effect of the solution. The residual effect was seen on filter-papers, in comparison with kerosene and blank. The pyrethrum solution paper was seen to kill fleas up to 30 days.

Table I indicates the mortality of fleas by the BHC and pyrethrum powders that may have remained on the rat body after only ONE entrance through the bait box, in the laboratory.

TABLE I  
*Laboratory Experiment*

Twenty fleas were used in all experiments. 4.6 gm. of powder was dusted in each box, the rat was passed through the box ONCE only, and the residual effect of the powder sticking to rat body was seen by the 24 hour % mortality of fleas released on the rat.

No. of days residual effect	5% BHC (%)	Pyrethrum dust 0.04 (%)		Pyrethrum extract 0.04% in kerosene oil on filter-paper. Expo- sure of fleas in test- tubes		
		Control	Control	Pyrethrum extract+K	Kerosene only	Control
24 hours	100	Nil	75	nil	100 %	100 %
2nd day	100	"	70	"	100 %	100 %
4th "	80	"	80	"	100 %	100 %
5th "	75	"	70	"	100 %	100 %
6th "	"	"	75	"	100 %	100 %
7th "	73	Nil	"	"	100 %	100 %
8th "	65	"	"	"	100 %	100 %
15th "	"	"	"	"	60%	45%
20th "	"	"	"	"	100%	Nil

K=Kerosene.

The experiments were then shifted to the field area in the villages of Khari, Kalwa, Nala Sopara and part of the town of Buldhana. The bait boxes were dusted once with 4.6 gm. of the insecticide powder per 1.5 sq. ft. of space. Two to four boxes were kept in the houses along the rat-runs. Initially wheat flour dough was kept in one corner of the box to attract rats. Flea indices were taken initially and a number of days after laying the bait boxes. Table II shows the reduction in flea indices observed at the places of experiments. It will be seen from these figures that the incidence of fleas in the houses came down the very next day and continued to decrease. The experiments have been done for a minimum period of 8 days and a maximum of 22 days so far.

Table III shows the details regarding the number of houses taken, number of bait boxes used and the number of rats and fleas involved. The cost of each bait box is 50 nP. and the cost of the powder is 3 nP. per box. These boxes could be tried in the areas where spraying is resented and could be hung in attics and put near field rat burrows for the reduction of fleas.

## BAIT BOX

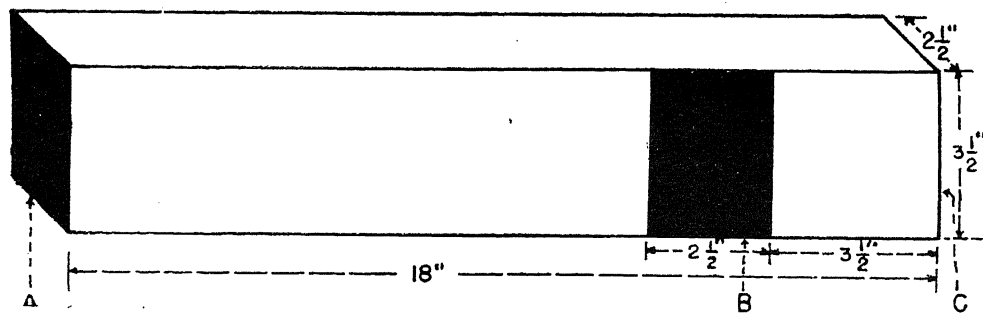


FIG. 1. Bait boxes of wood. A—Entrance; B—Middle exit; C—Closed end.

TABLE II  
*Field experiment with dusted bait boxes*

The boxes were dusted with 4.6 gm. of insecticide ONCE only and kept in houses along rat-runs. The reduction in flea indices observed for various periods are recorded here

Flea index after days	Khari		Kalwa		Buldhana		Nala Sopara		Sopara	
	5% DDT	Control	5% DDT	Control	5% DDT	Control	0.02% pyrethrum	Control	10% DDT	Control
Initial	..	4.25	4.1	0.94	0.94	2.6	2.5	4.0	4.1	4.3
24 hours	..	0.14	6.0	..	..	0.90	2.7	..	..	4.3
5th day	..	0.11	2.9	..	..	..	..	..	..	..
8th day	..	0.14	6.0	0.13	..	..	..	0.54	2.9	..
10th day	..	0.0	2.9	..	..	..	..	..	0.62	4.3
15th day	..	..	..	0.13	1.02	..	..	..	0.77	3.3

Remarks :—Wheat dough was kept on the first day only, and the boxes were not disturbed till it was noticed that the rats had brought in hay and husk, whereafter they were removed. This happened after 8-10 days in all cases.

TABLE III  
Details of field experiments

Particulars	Khari	Kalwa	Baldhana	Nala Sopara	Sopara
Total population	.. 1561	9000	15970	300	2700
Total No. of houses	.. 223	800	4565	40	300
Total No. of houses taken for experiment	.. 223	500	250	30	50
Bait boxes used	.. 40	100	100	10	100
No. of traps used	.. 50	100	50	14	100
Duration of experiment (days)	8	12	11	5	15
Total rats collected	.. 392	1062	1051	54	233
Total fleas collected	.. 389	664	1667	186	682
<i>A. rattus</i>	.. 390	879	936	63	219
<i>B. bengalensis</i>	.. 2	nil	nil	nil	1
<i>Mac. musculus</i>	.. ..	..	86	..	..
<i>Simulium aserale</i>	.. 12	183	29	1	13

The significance of these preliminary studies lies in the fact that these bait boxes have reduced the flea indices in houses and their presence is not resented by the people as is done for the insecticidal spraying. The tests done by Patel *et al.*,<sup>6</sup> in Bombay State, Mohan,<sup>5</sup> and Krishnamurti,<sup>3</sup> with the standard W.H.O. insecticide kit, have indicated that *X. cheopis* has started showing resistance to certain insecticides, like DDT, as used in these kits. In the light of this it was needed to be seen whether DDT and BHC in powder form as is recommended for the control of plague still killed fleas and whether the use of pyrethrum as advocated by Deoras<sup>1</sup> could also be taken in hand. The present studies show that the powders of DDT and BHC are killing fleas and pyrethrum is also working. Thirdly the residual effect of pyrethrum was demonstrated by Deoras.<sup>1</sup> There is no resistance so far observed to this insecticide, it should therefore be given a trial in India on a large scale when a widespread resistance is shown by conventional poisons as DDT and BHC.

I am extremely thankful to the Directorate of Public Health, Mysore, for the facilities placed at my disposal during the observations in March 1963, to the I.C.M.R. authorities for the scheme, the Director of Public Health, Maharashtra, for the location, and to Messrs. Bade, Shah, Renapurkar and Chaturvedi for the ungrudging assistance during observations in most difficult circumstances.

Haffkine Institute,  
Bombay-12, July 11, 1963.

P. J. DEORAS.

1. Deoras, P. J., *Int. Jour. Pharmacy*, 1960, **22**(9), 226.
2. Kartman, L., Prince, F. M., Quan, F. S. and Stark, H. F., *Ann. N.Y. Acad. Sci.*, 1958, **70**(3), 668.
3. Krishnamurthi, B. S. and Joshi, G. C., *Int. Jour. Malaria*, 1962, **16**(2), 137.
4. Macchiavello, A., *Am. J. Pub. Health*, 1946, **36**, 842.
5. Mohan, B. M., *Ind. Jour. Malaria*, 1962, **16**(3), 277.
6. Patel, T. B., Bhatia, S. C. and Deobhankar, R. B., *Bull. Wild. Hlth. Org.*, 1960, **23**, 301.
7. Pollitzer, R., *Acta tropica*, 1949, **6**, 36.
8. *Report on Kolar Tour Haffkine Institute*, 1963 (Personal Communication).

### THE PECTOLYTIC ACTIVITY OF A SEWAGE EPISTYLIS SP.

The luxuriant growth and development of *Epistylis* sp., *Carchesium* sp. and other stalked ciliate protozoa is one of the essential conditions for the rapid purification of sewage under natural conditions.<sup>1</sup> It was of interest to us to ascertain whether or not *Epistylis* sp. and other protozoa *in situ* have any ability to decompose pectin in sewage. Raw sewage has been shown to contain 1.24% pectin on total dry matter basis.<sup>2</sup> The raw sewage collected at this Institute Sewage Works also contained about 1.31% pectin<sup>3</sup> on total residue basis.<sup>4</sup>

The protozoal masses of *Epistylis* sp., collected from the sewage channels near Bangalore City, were first allowed to settle in a cylinder. The supernatant was drawn off and the sediment was washed twice with tap-water by this procedure. Thereafter, the protozoa were centrifuged at a low speed (1,500 r.p.m.), washed once with distilled water and twice with normal saline. The washings with water helped to break up the bacterial clumps.<sup>5</sup> This procedure, it was observed, did not harm in any way the protozoal population. The supernatant in the final wash was taken as a control as it carried a greater load of bacteria than did the sediment ( $30.7 \times 10^9$  and  $49.6 \times 10^5$  per ml. respectively as enumerated on Nutrient agar). The final sediment, comprised of *Epistylis*, was suspended in as small a volume of normal saline as possible. A typical *Epistylis* preparation made in this manner contained 56 mg./ml. protein as measured spectrophotometrically.<sup>6</sup>

Using pectin and polygalacturonic acid (both from Eastman Organic Chemicals, Rochester) as substrates (at 0.5% levels) in a suitable buffer, and the inocula at 0.1% level (*Epistylis* preparation and their final wash), pectin poly-

galacturonase (PG) and pectin methylesterase (PE) activities were tested by alcohol precipitation and  $\text{CaCl}_2$ -gel formation respectively.<sup>7</sup> The protozoal preparation revealed the presence of both these enzymes. Their presence was further confirmed by estimating PG by Kertesz's method, PE by Lineweaver and Ballou's method and pectin *trans*-eliminase (PTE) by Nagel and Vaughn's method (as modified previously).<sup>8</sup>

TABLE I

*Pectolytic activity of the samples, after 24 hrs.*

Preparation	PG measured as increase in reducing power in terms of ml. of 0.05 N $\text{Na}_2\text{S}_2\text{O}_5$ solution	PE measured as ml. of 0.02 N NaOH required	PTE measured as units of O.D. (if a peak at 235 m $\mu$ )	Polygalacturonic acid
<i>Epistylis</i>	0.5	0.03	0.82	1.2
Final Wash				
Control	0.2	0.01	..	..

Suitable controls (boiled and uninoculated) kept along with served as negative controls. The *Epistylis* preparation showed 2-3 times more PG and PE activity than final wash control. The PTE activity was present only in the *Epistylis* preparation. This protozoal preparation, unlike that of *Streptomyces*, viz., *S. viridochromogenes*,<sup>9</sup> preferred polygalacturonic acid to pectin as the substrate.

The chromatography of the degradation products of pectin and polygalacturonic acids showed the presence of galacturonic acid in both the cases, but there was some difference in the formation of other di-, tri-, tetra-oligouronides, as judged from their  $R_m$  values. The *Epistylis* preparation with pectin gave a spot similar to galacturonic acid (same  $R_f$  value) and other faint spots of di-, tri-, and tetra-oligouronides. With polygalacturonic acid it gave faint spots of galacturonic acid and a trimer whereas the dimer spot was intense. The final wash control gave spots of galacturonic acid with both pectin and polygalacturonic acid but there was no indication of other oligouronides. The absence of a dimer in this material provided further evidence of the lack therein of PTE activity.

The rate of pectin decomposition as brought about by the protozoal preparation and the final wash control was then determined by measuring residual pectin according to the method of Kaiser.<sup>10</sup> The former could decompose as much as 42.8% pectin in 24 hrs., whereas the latter could do so only to 6.3% extent. An acetone

powder from the former also showed similar results.

The observations clearly bring out the presence of pectolytic enzymes in *Epistylis* sp. and point to the possible role the organism has in the purification of sewage by decomposing such organic substrates as pectin. It is likely that other important protozoa in sewage also have the same or other enzymes capable of degrading such complex substances as pectin. Investigations on these aspects are in progress.

The authors are grateful to Dr. S. C. Pillai of the Department of Biochemistry for the identification of the protozoan and the Director, Indian Institute of Science, for his keen interest.

Fermentation Technology Lab., A. D. AGATE.  
Indian Institute of Science, J. V. BHAT.  
Bangalore-12, September 7, 1963.

1. Pillai, S. C., Mohanrao, G. J., Prabhakara Rao, A. V. S., Sastry, C. A., Subrahmanyam, P. V. R. and Natarajan, C. V., *Curr. Sci.*, 1960, **29**, 461.
2. Henkelekan, H. and Balmat, J. L., *Seaw. and Ind. Wastes*, 1959, **31**, 413.
3. Kertesz, Z. I., *The Pectic Substances*, Interscience, New York, 1951.
4. *Standard Methods for the Examination of Water, Sewage and Industrial Wastes*, American Pub. Health Assoc. Inc., New York, 1955.
5. Butterfield, C. T., *Pub. Health Repts.*, 1935, **50**, 671.
6. Warburg, O. and Christian, W., *Biochem. Z.*, 1941, **310**, 384.
7. Agate, A. D. and Bhat, J. V., *Antonie van Leeuwenhoek*, 1963 (In press).
8. — and —, *J. Indian Inst. Sci.*, 1963, **45**, 49.
9. —, Bilimoria, M. H. and Bhat, J. V., *Curr. Sci.*, 1962, **31**, 462.
10. Kaiser, P., *D.Sc. Thesis*, Paris Univ., 1961.

## SUGAR COMPOSITION OF NECTAR IN COCONUT

LITTLE is known regarding the constancy and characteristic occurrence of sugars, amino-acids, dicarboxylic acids, enzymes and proteins in the nectar of plants. Wykes' finding,<sup>1</sup> that the occurrence of various sugars and their relative proportions tended to remain constant in nectar from any one species and is characteristic for certain families, has been corroborated by Percival.<sup>2</sup> The composition, however, varies within certain limits, depending on various climatic, edaphic and physiological factors.<sup>2</sup> In *Melilotus alba*, Wilson *et al.*<sup>3</sup> suggested even intra-varietal variation in the composition of nectar. Wykes (*loc. cit.*) has also reported the selective preference of nectar of particular composition by bees.

In the coconut, there appear to have been no data reported so far on this taxonomically

important aspect. Preliminary studies were, therefore, undertaken at this Research Station with a view to assess qualitatively and quantitatively the sugar composition of the nectar of pistillate as well as staminate flowers of coconut employing paper partition chromatographic technique.

The nectar was collected by means of fine glass capillary tubes from inflorescences previously bagged to prevent any possible contamination. These were then analysed by circular paper chromatography using Partridge's solvent as developer and 1% resorcinol in alcoholic hydrochloric acid as spray reagent (Forsyth). Comparative quantitative examination were carried out based on the intensity of colour of the spots developed. Controls with standard stock solutions of the respective sugars were also run for comparison.

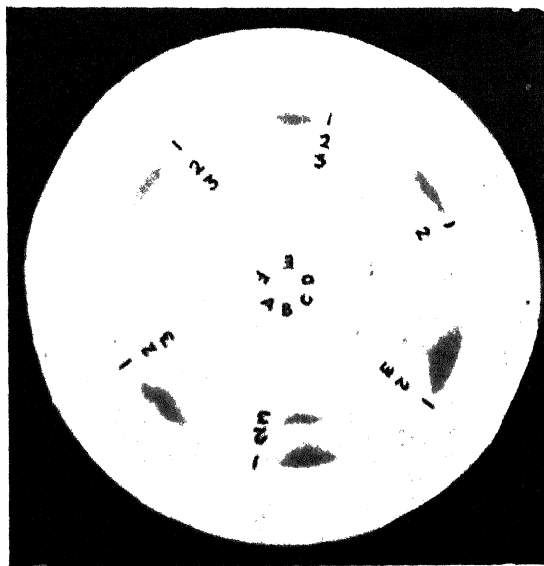


FIG. 1. A, Straits Settlement (Green); B, Laccadive pink; C, Spicata; D, Laccadive minor; E, Dwarf; F, Tall. 1. Fructose, 2. Glucose, 3. Sucrose.

It was seen from the chromatograms that, although, the quantity of sugars in the nectar of pistillate flowers varied to some extent from tree to tree, the type of nectar of all samples analysed invariably belonged to the SFG pattern with dominance of fructose and glucose in the above order. This is in general agreement with the observations made by Percival (*loc. cit.*) who reported the association of F and G dominated nectars with open flowers having unprotected nectar. There is a general uniformity in the composition of nectar between the West

Coast tall and the dwarf varieties of coconut which are otherwise considered widely distinct. The spicata palm and the natural hybrids of dwarfs which were also examined for their nectar composition did not show any variation from the general SFG type. While almost all the other geographically distinct races of coconut examined so far indicate a striking similarity in their basic nectar pattern already described, the Laccadive types appear to be exceptionally different from other geographically distinct races in their basic nectar characters. In Laccadive small the basic character of SFG is retained; in Laccadive pink the sucrose content is comparatively high, attaining more or less a balanced SFG composition, and in Laccadive minor the nectar type is distinctly different and can be technically called honey since F and G constitute the sole sugar constituents in this type. These findings thus appear to suggest the possibility of inter-varietal variation in the sugar composition of nectar and deserve further clarification to assess their taxonomical value.

Observations recorded on the sugar composition of the nectar of staminate flowers are particularly interesting. In all the samples so far examined the pistillode nectar of male flowers contain only fructose. Whether this variation in the composition of nectar between male and female flowers of the same tree bears any biological significance in relation to the pollinating insects and other allied factors is yet to be ascertained. Work to elucidate these is now in progress.

My grateful thanks are due to Dr. K. M. Pandalai, Director, for his guidance and Mr. N. G. Pillai, Research Assistant, for his valuable help in carrying out this study.

Central Coconut T. O. PRASANNAKUMARI.  
Res. Stn., Kasaragod, April 17, 1963.

1. Wykes, G. R., *New Phytologist*, 1952, **51** (2), 210.
2. Percival, Mary S., *Ibid.*, 1961, **60**, No. 3.
3. Wilson, W. T., Mafett, J. O. and Harrington, H. D., *Bull. Colo. St. Univ. Exp. Stat.*, 1958, p. 503.
4. Forsyth, W. G. C., *Nature*, 1948, **161**, 239.

#### A NOTE ON THE GEOLOGY OF THE SOUTH-WESTERN PART OF KANNEGIRI HILLS, ANDHRA PRADESH

A GEOLOGICAL account of south-western part of the Kannegiri Hills (Long. 80° 33', Lat. 17° 19') of the Khammam District of Andhra Pradesh, comprising roughly 50 sq. miles, is presented in this note.

According to Mahadevan<sup>1</sup> (1949), the Kannegiri Hills consist of garnetiferous quartzites and these crop out amidst massive intrusions of hornblende-granites. On the basis of their field occurrence and grade of metamorphism Heron<sup>2</sup> suggested that the isolated Kannegiri Hills consisting of garnetiferous quartzites may indicate a connecting link between the Pakhals at Khammam and the Khondalites of Godavary gorge. The Charnockites to the South of the area, according to the same authority are the deep-seated, highly metamorphosed equivalents of the massive epidiorites and hornblende granites which surround the Kannegiri Hills.

The authors, during the course of detailed field investigations of the south-western part of Kannegiri Hills, noticed that the rocks are not hornblende-granites but consist of a wide variety of lithological types which include hornblende-schists, amphibolites, hornblende-plagioclase-granulite-gneisses, etc., with their garnetiferous varieties (these may be termed as hornblende series), oligoclase-quartz-biotite-gneisses and metadolerites.

The regional strike of the rocks trends roughly 280° to 290° with high dips of 65° to 70° towards south-west. Some of the oligoclase-quartz-biotite-gneisses show a conspicuous shift in strike from 290° to 250°.

The area is traversed by a number of thin pegmatites showing characteristic ptygmatic folding. The width of the pegmatite veins vary from 3 to 6 cm. The trend of the veins is similar to that of the host rock. These show gradational contacts with the associated hornblende schists and amphibolites.

Hornblende-schists, wherein the schistosity is not conspicuous, have plagioclase (An 35-40%) hornblende, quartz, apatite, magnetite and sphene. Hornblende has the following optical properties:

X—Pale green; Y—Green; Z—Dark green;  $2V = 70^\circ$ ;  $Z\wedge c = 20^\circ$ ; opt. sign. (—).

The amphibolites are chiefly composed of hornblende (73.08%), plagioclase (19.37%), and a little quartz (6.84%), apart from minor accessories. Schistosity is not conspicuous megascopically, while a preferred orientation of hornblende can be observed.

The hornblende-plagioclase-gneisses are medium-grained and have granulitic texture. The plagioclase (An 40-45%) forming a little more than half of the rock is somewhat clouded due to the presence of hornblende inclusions and opaque dust. The garnet is identified as

almandine. The hornblende is similar to that present in schists.

Oligoclase-quartz-biotite gneiss, in which there is a dimensional orientation parallel to regional strike, contain poorly twinned plagioclase (52%) and biotite (15%) which is strongly pleochroic from yellow to dark brown.

Metadolerites are characterised by the presence of hornblende (38%), hypersthene and augite (18%), plagioclase and a little quartz. Hornblende, hypersthene and augite are highly altered.

Preliminary field investigations suggest that the evolution of the plutonic rocks of the south-western part of Kannegiri Hills is not entirely determined by the local physico-chemical conditions but that metasomatism has also played a considerable part. For instance, the hornblende-plagioclase-gneisses seem to have been evolved from the hornblende-schists by the replacement of hornblende by plagioclase. Textural studies appear to support the conclusion drawn from field investigations.

The authors are thankful to Dr. S. Balakrishna for valuable suggestions.

Geology Department, Y. JANARDAN RAO.  
Univ. College of Science, K. SURYA PRAKASH RAO.  
Osmania University,  
Hyderabad-7, April 1, 1963.

1. Mahadevan, C., *A Re-examination of Some Aspects of the Puranas and Archaeans of South India*, Presidential Address, Section of Geology and Geography, Indian Science Congress, 1949.
2. Heron, A. M., "Synopsis of the Purana Formations of Hyderabad," *Journal of Hyderabad Geological Survey*, 1949, 5, Part 2.
3. Janardan Rao, Y., *Plutonic History of Yellandlapad Area*. Thesis submitted to the Osmania University, 1959.

#### **OCCURRENCE OF *RADOPHOLUS SIMILIS* (COBB, 1893) THORNE, 1949, IN ABBOTTABAD, WEST PAKISTAN**

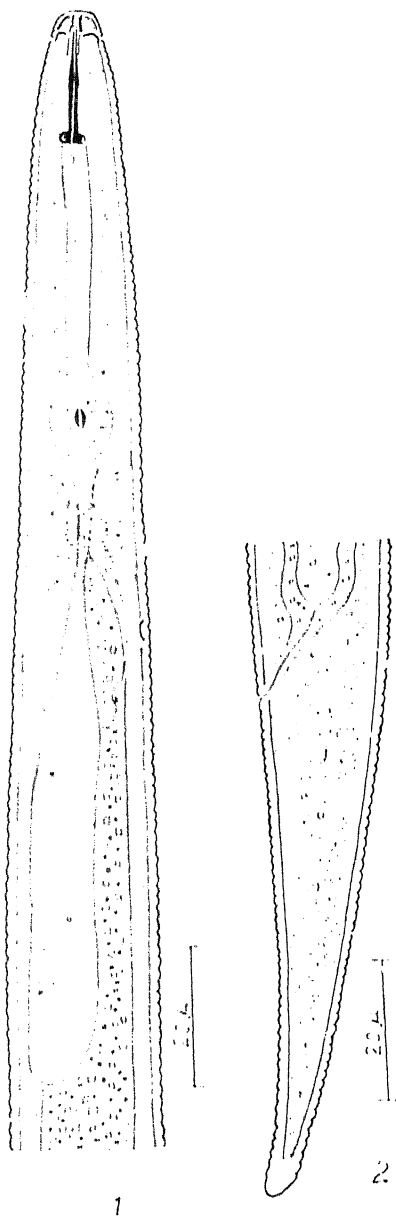
*Radopholus similis* is an important parasite of banana, citrus, black pepper and other plants.

In April 1961, the author found a few specimens of *Radopholus similis* in soil around pine roots in Abbottabad, West Pakistan. Measurements and a few important characters of the worm are given below:

*Female*.—Measurements: Length = 0.7 mm.;  $a = 27$ ;  $b = 8.7$ ;  $c = 10$ ;  $V = 55\%$ .

Body eel-like. Head low, rounded, bearing 4 annules; labial framework highly sclerotized. Spear strong,  $17\mu$  long. Oesophageal glands in separate lobes, lying on dorsal side of anterior

end of intestine (Fig. 1). Ovaries paired, outstretched in opposite directions; tip of posterior ovary reflexed. Spermathecae absent. Tail elongate-conoid; phasmids located one and-a-half body-width behind level of anus.



FIGS. 1-2. *Radaphysa similis*. Fig. 1. Oesophageal region of female. Fig. 2. Tail of female

*Habitat*.—Found around pine roots (*Pinus creelsa* Wall.).

*Locality*.—Near District Court, Abbottabad, West Pakistan.

Cobb (1915) and van Weerd (1958) described the oesophageal glands as being in the form of separate lobes while Thorne (1961) thought these to be united into single lobe. The present study confirms the views of Cobb (1915) and van Weerd (1958) about the oesophageal glands.

Department of Zoology, M. RAFIQ SIDDIQI.  
Aligarh Muslim University,  
Aligarh, February, 5, 1963.

1. Cobb, N. A., *Jour. Agr. Res.*, 1915, 4 (6), 561.
2. Thorne, G., *Principles of Nematology*, McGraw-Hill Publ., 1961, pp. 553.
3. van Weerd, L. G., *Nematologica*, 1958, 3 (3), 184.

### CHLORIDE REGULATION IN *MARPHYSA GRAVELYI* SOUTHERN

*Marphysa gravelyi* Southern, an Eunicid polychaete, essentially a burrower, enjoys a wide distribution in the brackish-water regions of Madras, where the salinity of the medium varies widely from almost fresh to sea-water.<sup>1</sup> This worm tolerates sea-water dilutions to 20% and regulates its body volume better (unpublished data) than other polychaetes found in similar habitats.<sup>2</sup> Further, isolated muscle preparations are active in dilute media ranging between 20% and 50% sea-water (34%).<sup>3</sup> A study of the blood chloride level at  $27.5 \pm 0.5^\circ \text{C}$ ., using the method of Sendroy<sup>1</sup> as modified by Robertson and Webb,<sup>5</sup> shows that the chloride ions are actively regulated as the following Table would show. The chloride levels are

TABLE I

Exp. No.	Salinity of experimental medium %m	Mean chloride values of blood after 24 hrs. of exposure			
		gm./l.	S.d.	S.e.	No. of estimations
1	5.68	9.64	0.011	$\pm 0.005$	3
2	8.52	10.68	0.029	$\pm 0.016$	3
3	10.60	12.76	0.011	$\pm 0.004$	8
4	14.60	14.39	0.014	$\pm 0.005$	8
5	15.30	11.87	0.014	$\pm 0.004$	12
6	16.60	13.94	0.007	$\pm 0.002$	12
7	16.20	10.83	0.017	$\pm 0.006$	8
8	18.40	14.09	Nil	Nil	4
9	19.50	14.84	0.035	$\pm 0.012$	8
10	21.60	15.42	0.009	$\pm 0.003$	12
11	23.00	14.09	0.012	$\pm 0.003$	8
12	25.92	16.04	0.021	$\pm 0.006$	12

always higher in the hyposmotic media and lower in hyperosmotic media and thus maintaining a steady level (Fig. 1). Such a regulation has not been reported in any polychaete so far,

although similar work on *Nereis diversicolor* is available (Smith<sup>6</sup>). The mechanism underlying the regulation is being studied.

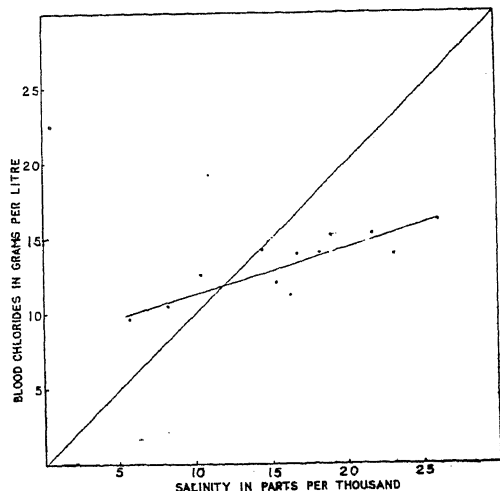


FIG. 1

The author is grateful to Dr. S. Krishnaswamy and to Dr. N. K. Panikkar for suggestions and criticism.

Zoological Res. Lab., B. KRISHNAMOORTHY.  
University of Madras,  
Chepauk, Madras-5, April 6, 1963.

1. Panikkar, N. K. and Aiyar, R. G., *Proc. Ind. Acad. Sci.*, 1937, **6**, 284.
2. Krishnamoorthi, B., *Ibid.*, 1962, **56**, 363.
3. — and Krishnaswamy, S., *Ibid.*, 1963, **57**, 83.
4. Sendroy, J., *J. biol. Chem.*, 1937, **120**, 335 & 405.
5. Robertson, J. D. and Webb, D. A., *J. Exp. Biol.*, 1939, **16**, 155.
6. Smith, R. I., *Biol. Bull.*, 1955 c, **109**, 453.

### CHILLI (*CAPSICUM ANNUM*)—A NEW HOST PLANT OF *HELIOTHIS ARMIGERA*, HB.

*Heliothis armigera*, Hb., the gram caterpillar of India, is a typical polyphagous insect attacking agricultural and garden crops, ornamental plants as well as some trees. It is cosmopolitan in distribution. It is also predaceous on larvae of other smaller species of Lepidoptera and cannibalistic too.

In India, it is recorded on a large variety of food plants.<sup>1-4</sup> So far, 34 host plants have been recorded in India. In Mysore State, it is commonly observed to be a serious pest of pulses—gram, tur, *Dolichos lablab* (Avare), Tomato, Jowar-earheads and cotton.

The present note relates to observations made on *Heliothis armigera* as a serious pest of chilli (*Capsicum annum*) which is a new record as host plant of this insect.

On chillies (*Capsicum annum*), it is observed to attack the capsules (fruits), boring them at the base near the stalk and completely destroying the contents (Fig. 1). It is a recognised fruit borer with a peculiar habit of having its posterior portion of the body outside the bored material. But on chillies, in certain cases it is observed to lodge itself completely within the capsules. This habit is observed for the first time.



FIG. 1

During May 1962, this pest was observed in Kolar District, to cause severe damage to the irrigated chilli crop aged about 4-5 months, with good bearing. Field studies on the incidence and extent of damage of this insect on chillies revealed that the average percentage of plants attacked was 92, and that 77% of the capsules were found bored and damaged. The average population of caterpillars per attacked plant was 6. The prevalence of this insect was observed to last from end of April to end of June. The young attacked capsules were found to dry up and shed, whereas well-developed ripened attacked fruits continued to remain on the plants.

The following procedure was adopted to control the pest with the application of the insecticides:

- (a) Before giving the application of the insecticides, the fruits (capsules) were harvested.



- (b) Harvesting of fruits was not allowed for about 25 days after the application of insecticides.
- (c) Two applications were given at an interval of 25 days. Of the insecticides tried, (i) DDT 50% W.P. at 1 lb. in 16 gallons of water, (ii) BHC 50% W.P. at 1 lb. in 16 gallons of water, (iii) Endrin 20% E.C. at 1 oz. in 3 gallons of water, were found to be effective in controlling this pest. (The insecticides are mentioned in the order of their efficacy.)

The author is indebted to Dr. M. Puttarudriah, Principal, for encouragement and guidance in this work and to Sri. M. Appanna for valuable suggestions.

Division of Entomology, S. S. KATAGIHALLIMATH, Agricultural College and

Research Institute,  
Hebbal, Bangalore-6, April 12, 1963.

1. Cotes, E. C., *India: Museum Notes*, 1891, **1**, 50, 97, 109.
2. Fletcher, T. B., *Report of the Proceedings of the Second Entomological Meeting, Pusa, 1917*.
3. —, *Report of the Proceedings of the Third Entomological Meeting, Pusa, 1919*, **1**, 60.
4. Puttarudriah, M., and Appanna, M., *Mys. Agri. Jour.*, July to September 1956, **31** (3).

#### NUCLEOLUS-SATELLITE RELATIONSHIP AT PROPHASE AND POLYSOMATY IN *CICER ARIETINUM* LINN.

The well-defined morphology of the satellites projecting out of the metaphase groups in side views, and the frequent persistence of the nucleoli, enabled a critical evaluation of the SAT-nucleolus relationship in the meristematic cells of *Cicer arietinum*.<sup>1,2</sup> In instances where the nucleolus disintegrates at the end of prophase and the satellite morphology is indistinct or variable during meta- and ana-phases, the nucleolus-satellite association elucidated at telophase has to be confirmed by a study of the prophase stages.<sup>3</sup> The disagreement whether *C. arietinum* has two<sup>4</sup> or only a pair<sup>5</sup> of satellited chromosomes extends even to the question whether the nucleolus is associated at prophase with the SAT-chromosomes alone<sup>4</sup> or with the non-satellited chromosomes as well.<sup>5</sup> Since critical observations in this context are difficult owing to the overlapping of the prophase chromosomes, it became necessary to contract them by the use of some agency.

The ability of *p*-dichlorobenzene to inhibit spindle formation<sup>6,7</sup> and contract the chromosomes has found wide application in investigations on the chromosome morphology of many plants. The temperature and time of exposure to the chemical,<sup>8-10</sup> the mode of handling—squash or section<sup>9,11</sup>—and the choice of fixatives and stains appear to be determined by the type of material studied.

Primary and secondary roots of *C. arietinum* were exposed to a saturated solution of *p*-dichlorobenzene (Riedel-de Haën sample) for 90 minutes, washed thoroughly in water, fixed in acetic alcohol (1:3) for 24-72 hours, stained with hæmatoxylin<sup>12</sup> and then squashed. The illustrations presented are from temporary as well as permanent preparations.

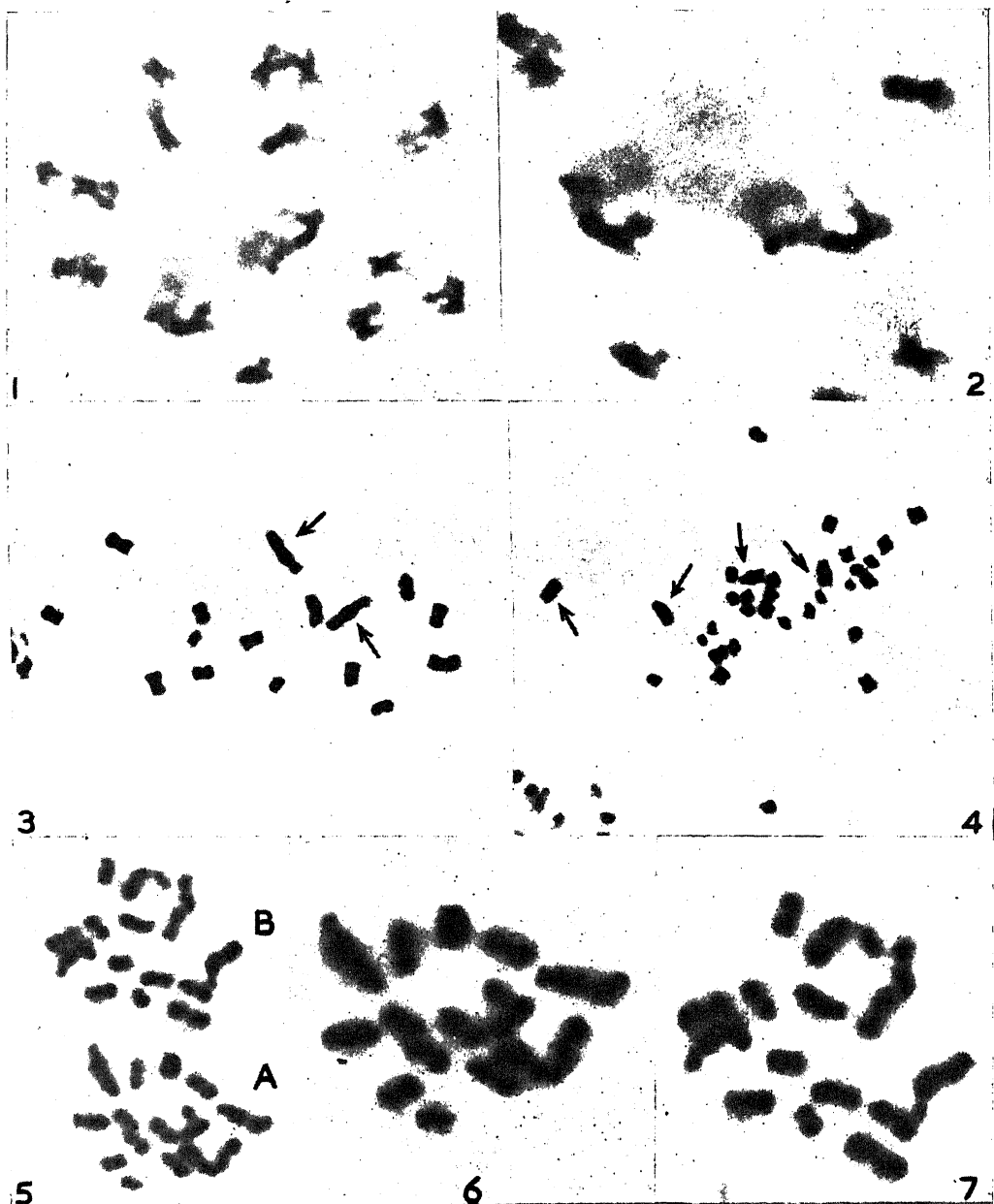
Photo 1 is of a cell at late prophase in which the 16 chromosomes are visible. The nucleolus is associated with only the pair of SAT-chromosomes. The enlargement (Photo 2) reveals that the chromosomes found in association with the nucleolus have tandem satellites and that the nucleolar matter forms a collar.<sup>2,13-17</sup> Attention is invited to the densely stained ring-shaped areas in the nucleolus which enclose the SAT-threads. It is difficult at present to surmise their significance.

The occurrence of cells with a tetrasomatic complement of chromosomes in the developing roots of *C. arietinum*<sup>4</sup> appears to be a common phenomenon in Leguminosæ.<sup>18,19</sup> The difficulty in scattering the chromosomes of such cell types in squashes, precludes an accurate estimate of their number. Pretreatment with *p*-dichlorobenzene facilitates an accurate count. Photos 3 and 4 are of metaphases having 16 and 32 chromosomes respectively. The clarity of the satellite morphology depends on the degree of contraction of the chromosomes (arrows, Photo 3) and when it is excessive, this may be completely obscured, necessitating an identification of such chromosomes purely by their relative lengths (arrows, Photo 4).

A rather intriguing discovery was the accentuation in treated cells, of a substance usually found coating the late anaphase chromosomes in normal roots. This substance, which is Feulgen-negative, begins to appear when the sister-chromosomes have separated. In Photo 5 each of the 16 chromosomes in the two anaphase groups (A & B) exhibits a well-defined lighter staining coat. The enlargements of the groups (Photos 6 and 7) illustrate this

feature clearly. Further exploration is necessary to understand the significance and role of this Feulgen-negative chromosomal coat.

The junior author (G. M.) is grateful to the University Grants Commission for the award of a Research Fellowship.



PHOTOS 1-7. Photo 1. Prophase with 16 chromosomes. Two chromosomes with tandem satellites are seen associated with the triangular nucleolus,  $\times ca. 1,800$ . Photo 2. Enlargement of the nucleolus. Nucleolar matter forms a collar around the SAT-thread. Note the densely stained rings enclosing the SAT-thread,  $\times ca. 3,100$ . Photo 3. Metaphase with 16 chromosomes,  $\times ca. 1,950$ . Photo 4. Metaphase with 32 chromosomes,  $\times ca. 1,550$ . Photo 5. Anaphase. Each chromosome has a lighter staining coat,  $\times ca. 2,100$ . Photos 6 and 7. Enlargements of the two anaphase groups marked A and B in Photo 5,  $\times ca. 3,200$ .

Cytogenetics Lab., (Miss) G. MEENAKSHI.  
Dept. of Biochemistry, M. K. SUBRAMANIAM.  
Indian Institute of Science,  
Bangalore-12, August 19, 1963.

- 1, 2. Meenakshi, G. and Subramaniam, M. K., *Proc. Ind. Acad. Sci.*, 1962, **55 B**, 15; 1963, **57 B**, 73.
3. Gates, R. R., *Bct. Rev.*, 1942, **8**, 337.
4. Iyengar, N. K., *Ann. Bot. N.S.*, 1939, **3**, 271.
5. \*Dombrowska-Slutskaia, L., *Biol. Abs.*, 1931, Entry No. 13395.
6. Simonet, M. and Guinocet, M., *Compt. Rend. Soc. Biol.*, 1939, **130**, 1057.
7. Carey, M. A. and McDonough, E. S., *Jour. Hered.*, 1943, **34**, 238.
8. Meyer, J. K., *Stain Technol.*, 1945, **20**, 121.
9. Mendes Conagin, C. H. T., *Ibid.*, 1951, **26**, 274.
10. Sharma, A. K. and Mookerjee, A., *Ibid.*, 1955, **30**, 1.
11. \*Dermen, H. and Scott, D. H., *Proc. Amer. Soc. Hort. Sci.*, 1950, **56**, 145.
12. Marimuthu, K. M. and Subramaniam, M. K., *Curr. Sci.*, 1960, **29**, 482.
13. \*Heitz, E., *Planta*, 1931, **12**, 775.
14. Pathak, G. N., *Ann. Bot. N.S.*, 1940, **4**, 227.
15. \*Mulnard, J., *Arch. Biol.*, 1956, **67**, 485.
16. Subramanyam, S. and Royan, S., *Curr. Sci.*, 1962, **31**, 244.
17. Gopinath, P. M. and Subramaniam, M. K., *Ibid.*, 1963, **32**, 169.
18. Berger, C. A., Witkus, E. R. and McMahon, R. M., *Bull. Torrey Bot. Club*, 1958, **85**, 405.
19. Bouharmont, J., *La Cellule*, 1960, **61**, 7.

\* Not seen in original.

## EFFECT OF CHLOROX ON THE GERMINATION OF VANDA SEEDS

DURING the culture of plant tissues, it is a common practice to treat the inoculum with surface sterilizing agents such as sodium or calcium hypochlorite, bromine water, mercuric chloride, etc., in order to achieve aseptic cultures.<sup>1-3</sup> Surface sterilization of plant material is sometimes achieved by dipping the same in alcohol and flaming it. The different techniques practised to achieve sterile tissues are mentioned in several well-known works.<sup>3-5</sup> Some of the workers have also discussed the effect of disinfectants on the inoculum and its further growth.<sup>4</sup> Sometimes the duration of such treatment is also important, depending upon the wettability and the delicate nature of the tissues of different plant materials. Seeds usually receive longer treatment than other materials with such disinfectants. In some instances this was shown to result in an increased percentage of seed germination.<sup>4</sup>

An interesting observation noticed in the germination of *Vanda* seeds on such treatment with Chlorox is reported here. Seeds of a

hybrid *Vanda*<sup>3</sup> (Miss Joaquim; *V. teres* × *V. hookeriana*) were excised from the pod and treated with 5% Chlorox for 10 minutes. After washing these with sterile distilled water, they were inoculated on the medium as formulated by Vacin and Went.<sup>6</sup> The tissue turned green in 3 weeks' time, concomitant with the growth of the embryo that emerged out of the lignified seedcoat. In 10-12 weeks small seedlings were formed (Fig. 1, A). Usually on an average, 60-70% of cultures remained aseptic. With the intention of obtaining 100% success in eliminating the contamination, the seeds were directly transferred from the undehisced pod on to the culture medium in certain experiments as suggested by Holtum.<sup>3</sup> During the process the undehisced pod was immersed in absolute alcohol for 2-3 minutes, flamed, and then cut open with a sterilized blade. With the help of the inoculation needle, seeds were transferred on to the medium directly. No germination was observed in such seeds even after 12 weeks (Fig. 1, B).

Suspecting that the failure of germination was due to non-wetting of the seeds, some of them were washed with distilled and sterile water as before, but without the use of Chlorox, and then transferred to the culture tubes. Less than 1% of the cultures showed germination and most of them became contaminated eventually. On the other hand, seeds transferred directly from the pod on to the medium, which was specially modified to contain tomato juice or yeast extract germinated and formed robust seedlings within 8-10 weeks (Fig. 1, C). This leads to the reasoning that *Vanda* seeds not treated by Chlorox did not germinate, but in the presence of either tomato juice or yeast extract this inability was not evident. From these observations, it is suggested, washing with Chlorox helped the germination of *Vanda* seeds, probably by removing a germination inhibitor.

In an attempt to check the validity of this idea, a water extract of the mature seeds was added to the medium. Seeds washed with Chlorox and distilled water were inoculated on such a medium to see if the seed extract would suppress germination. In spite of the seed extract in the medium the seeds germinated. Nevertheless, this does not rule out the idea of a germination inhibitor in seeds, which, if present, could be thermolabile being destroyed in the autoclaving of the media, before inoculation. The alternative possibility is that washing with Chlorox could have rendered the seedcoat

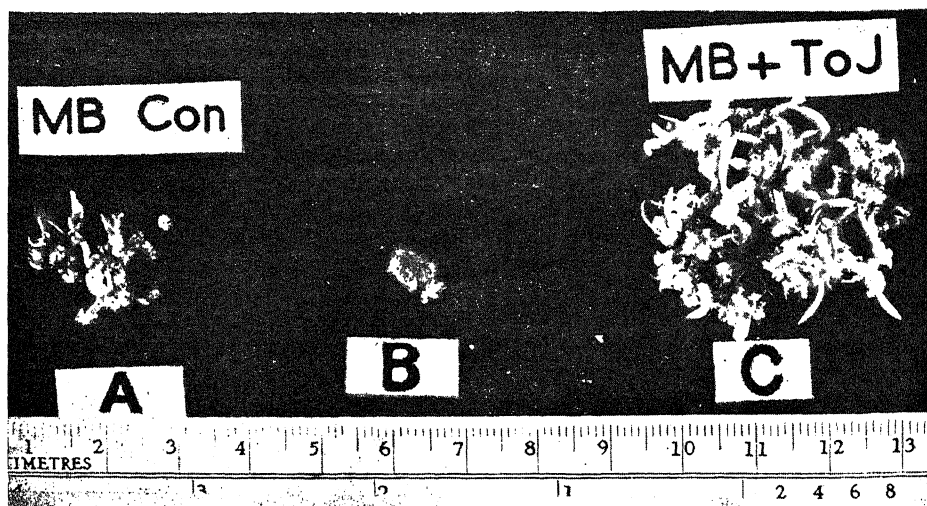


FIG. 1. A. Seedlings formed from *Vanda* seeds treated with Chlorox. B. Ungerminated seeds, not treated with Chlorox, transferred directly from the pod. C. Robust seedlings from seeds, untreated with Chlorox, transferred directly from the pod to the medium with tomato juice. (All 12 weeks old.)

readily permeable to water. Some have suggested that in nature, probably, micro-organisms present in the soil may aid the seeds in their germination.<sup>7</sup> Results of previous studies on the germination of orchid seeds do not indicate such role of disinfectants, when used before culturing the orchid seeds under laboratory conditions.<sup>8</sup>

Department of Botany,  
University of Singapore,  
Singapore 10, May 14, 1963.

A. N. RAO.  
P. N. AVADHANI.

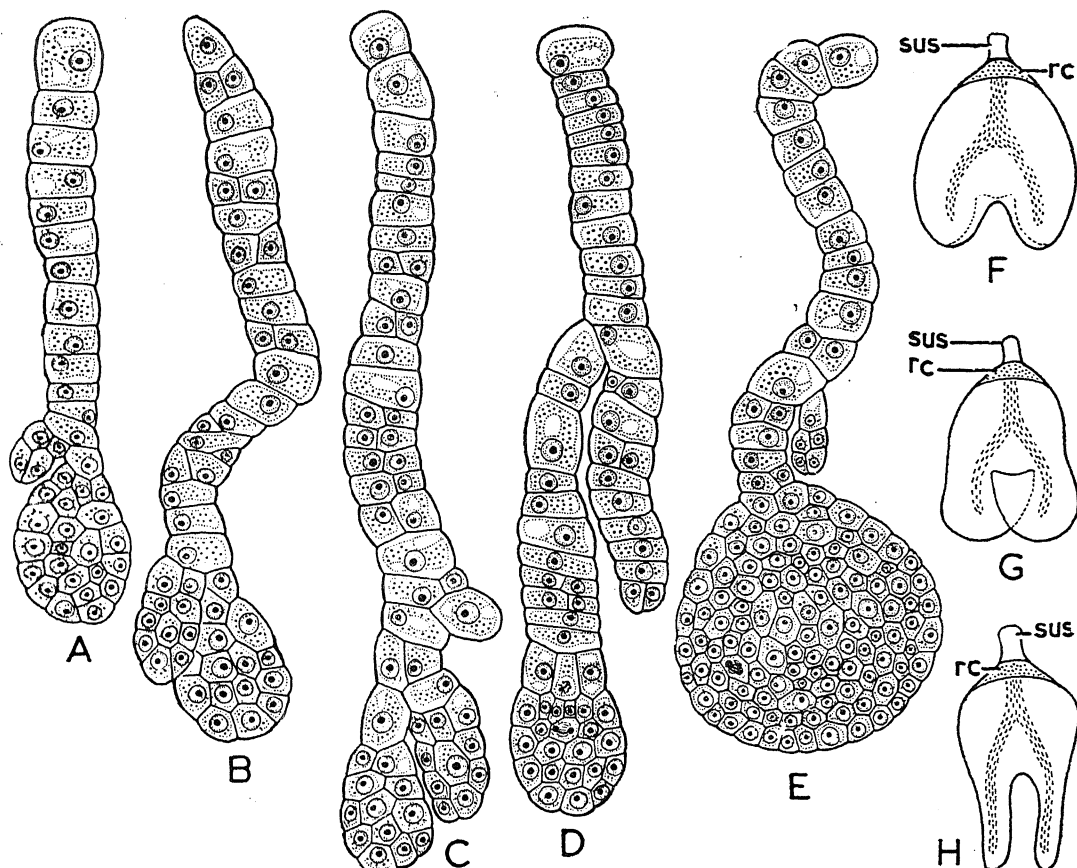
1. Wilson, J. K., *Amer. Jour. Bot.*, 1915, **2**, 420.
2. Knudson, L., *New Phytol.*, 1933, **32**, 115.
3. Holttum, R. E., *Orchids of Malaya*, Singapore, 1953.
5. Gautheret, R. J., *La culture des Tissus Vegetaux*, Masson & Cie, Paris, 1959.
5. White, P. R., *The Cultivation of Animal and Plant Cells*, Ronald Press Co., New York, 1954.
6. Vacin, E. and Went, F., *Bot. Gaz.*, 1949, **110**, 605.
7. Bernard, N., *Ann. Sci. Nat. Bot.*, 1909, **9**, 1.
8. Withner, C. L., *The Orchids*, Ronald Press Co., New York, 1959.

#### SUSPENSOR POLYEMBRYONY IN *GARRYA VEATCHII* KELL.

HALLOCK'S<sup>3</sup> work on the embryology of *Garrya* is incomplete. With a view to throw some light on its disputed systematic position, a detailed investigation of the embryology of *G. veatchii* was undertaken in 1962. While studying the development of the embryo I came across several instances of suspensor polyembryony which is described below.

After fertilization the zygote elongates vertically, becomes vacuolated and divides transversely to form a terminal and a basal cell. These cells undergo another transverse division to give rise to a linear proembryo. Further transverse divisions in the derivatives of the basal as well as in a few daughter cells of the terminal cell result in a filamentous, 15-25 cells long, proembryo. The terminal cell of this multicelled structure undergoes two vertical divisions, at right angles to each other, producing the quadrant. This is followed by the formation of an octant. Further longitudinal and transverse divisions result in a globular proembryo.

Additional embryos begin to develop from the cells of the suspensor when the embryo is at the globular stage. A few cells situated above the embryonal mass (Figs. A-C, E) or in the middle portion of the suspensor (Fig. D) bulge prominently. They undergo a transverse and then a longitudinal division to form a 4-celled proembryo (Fig. A). Further transverse and longitudinal divisions lead to the formation of a small globular proembryo (Figs. B, C). Sometimes the suspensor embryo may undergo a series of transverse divisions so that it becomes several cells long (Fig. D). Although one, two or three proembryos may develop simultaneously from the suspensor, their growth is usually arrested at the globular stage or even earlier. Ultimately, however, only the normal embryo reaches maturity. It differentiates into the heart-shaped and then to the dicotyledonous



FIGS. A-H. *G. veatchii*. Figs. A-E. Stages in the development of the suspensor embryos. Figs. F-H. Heart-shaped, dicotyledonous and mature embryos. Figs. A-E,  $\times 275$ ; Figs. F, G,  $\times 75$ ; Fig. H,  $\times 50$ . (rc, root cap; sus, suspensor).

stages (Figs. F-H). The cotyledons are large and flat and show a prominent vascular supply.

Suspensor polyembryony has been reported earlier in a few other angiosperms like *Lobelia syphilitica* (Crété<sup>1</sup>), *Actinidia chinensis* (Crété<sup>2</sup>), *Sonerila wallichii* (Subramanyam<sup>6</sup>), *Isotoma longiflora* (Kausik and Subramanyam<sup>4</sup>) and *Dipteracanthus patulus* (Maheshwari and Negi<sup>5</sup>). In *Garrya*, *Dipteracanthus* and *Sonerila* although the suspensor cells are potentially capable of producing additional embryos, the mature seed ultimately contains a single embryo. In some other plants, however, the seeds are found to possess more than one embryo.

I am indebted to Dr. R. N. Kapil and Professor P. Maheshwari for their inspiring guidance and help, to Professor M. F. Moseley of the University of California, Santa Barbara, U.S.A., for the material of *G. veatchii* used in this study, and to the Government of India for the award of a Research Training Scholarship.

Department of Botany,  
University of Delhi,  
Delhi-6, June 12, 1963.

P. R. MOHANA RAO.

1. Crété, P., *Bull. Soc. Bot. France*, 1938, **85**, 580.
2. —, *Ibid.*, 1944, **91**, 89.
3. Hallock, F. A., *Ann. Bot.*, 1930, **44**, 771.
4. Kausik, S. R. and Subramanyam, K., *Curr. Sci.*, 1946, **15**, 257.
5. Maheshwari, P. and Negi, V., *Phytomorphology*, 1955, **5**, 456.
6. Subramanyam, K., *Proc. Indian Acad. Sci.*, 1944, **19 B**, 115.

#### X-RAY INDUCED TALL MUTANT OF BLACK GRAM (*PHASEOLUS MUNGO* L.)

IN order to induce mutations by X-rays in black gram (*Phaseolus mungo* L.) dry seeds of a day neutral variety T. 9 were irradiated with a dose of 40,000 r. X-rays. In the  $X_1$  generation, one plant was marked for its weak growth and light green patches on first three trifoliate

leaves. About 40% of the pollen grains were empty and shrunken and the plant gave only a few fruits.

The progenies of this plant were raised and in  $X_2$  generation, out of 8 plants obtained 3 appeared conspicuously different because of their tallness and twining habit (Fig. 1). The plants



FIG. 1. (a) Normal, (b) Tall Mutant.

had greater height and longer internodes. The average height of the mutants was 75.14 cm. as compared to 23.7 cm. of the normal. The leaves were longer and narrower than the normal. The flowering started 3-4 days earlier and continued only for about 10 days in the first flush. In the normal plant the first flush generally continues for about a month. Flowers of the mutant were comparatively bigger, the spread of the standard petal being 1.83 cm. as compared to 1.55 cm. of the normal. The pollen fertility was normal but the average number of fruits produced was much smaller. The number of fruits per inflorescence was 1.4 as compared to 3.6 in normal plants. Progenies of these plants bred true.

Seeds from all the 5 normal looking  $X_2$  plants were sown. The progeny of one plant segregated into normal and tall mutant in the frequency 30 : 9 [ $\chi^2$  (3 : 1) = 0.077 ;  $P$  = 0.80-0.70].

The  $F_1$  plants obtained from the crosses normal + tall mutant and the reciprocal were normal. From the  $F_2$  generation the tall mutant was seen to inherit as a monogenic

recessive to the normal. The  $F_2$  families segregated in 3 normal : 1 mutant ratio as shown in Table I.

TABLE I  
 $F_2$  Segregation of normal  $\times$  tall mutant

Parents	Family	No. of $F_2$ plants		Total	$\chi^2$ (3 : 1)	P
		Normal	Tall			
Normal $\times$ Tall	1	60	19	79	0.39	0.90-0.80
	2	45	16	61	0.49	0.90-0.80
	3	60	16	76	0.631	0.50-0.30

Grateful thanks are due to late Dr. N. K. Sen for his keen interest in this investigation.

Applied Botany Section, MANAS K. JANA.  
Indian Institute of Technology,  
Kharagpur, March 18, 1963.

#### LEAF AGE, A FACTOR IN THE CONTROL OF KINETIN-REGULATED PROTEIN LEVEL IN ISOLATED TOBACCO LEAF DISCS

THE biochemical effects of kinetin in regard to the regulation of protein level in isolated leaf and leaf parts have been studied only by a few workers<sup>1-4</sup> and more recent work indicates that such simple factors as sucrose level might limit the kinetin response.<sup>3</sup> The present work was to examine the effect of kinetin on protein status of the isolated leaf tissues of *Nicotiana rustica* var. *Motihari* chiefly in relation to the physiological age of the leaf since in preliminary experiments it was observed that leaf discs obtained from healthy growing leaves failed to respond to kinetin treatment both in retaining the green colour and the protein content during culture.

Leaves of definite node positions were collected from uniformly growing plants and to ensure rigorous uniformity of sample leaf discs obtained from the two halves of the same leaf were taken for initial sample and for the discs cultured in water and in kinetin solution. Analyses of the discs obtained from two halves of leaves gave closely uniform values (Table I). Three leaves obtained from the same node positions from different plants were used for each experiment. Sixteen discs were punched from each leaf, eight from either half. Four of either half were analysed for initial sample and out of the remaining eight discs four were floated in 10 ml. of glass-distilled water in sterilized petri dishes and four in 10 ml. of 5 p.p.m. kinetin solution. Such samples obtained from three

leaves were marked and analysed separately. The values of triplicate analyses have been averaged for the initial sample as well as for water and kinetin-cultured discs at different time periods.

In experiments with the leaves from late-flowering plants usually third to fourth leaf below the inflorescence branch was taken. Ten discs were punched from each leaf; five from each half were floated in kinetin solution and in water respectively. The initial sample was taken not from the same leaf but from another similar leaf. The discs were maintained at 25° C. and received a light of  $3 \times 1,500$  lux from fluorescent tube-lights. Protein and soluble nitrogen were extracted by the usual TCA precipitation at 4° C. and subsequent centrifugation and were analysed separately by micro-kjeldahl technique as described elsewhere.<sup>5</sup>

TABLE I

Changes in the protein content in leaf discs\*  
from 90 days old vegetative plants  
mg.-N/4 discs (Diameter 1.9 cm.)

Node position		Initial † a/b	After six days of incubation	
			Kinetin	Water
6th	..	2.0/1.8	1.6	1.6
10th	..	1.2/1.2	0.9	0.8
18th	..	0.9/0.8	0.6	0.5

\* Leaf discs retained their initial appearance and remained healthy even after six days of incubation in both water and kinetin.

† a/b two halves of the leaves.

20%, 25%, to 33% respectively in leaves of the three physiological age groups (Table I). Kinetin retained protein level and also the green colour in the leaf discs obtained from the leaves of flowering plants. On the fifth day of culture while the kinetin-treated discs were green and healthy those in water turned completely yellow-brown and the almost collapsing leaf cells oozed out brownish fluid in the outside media. The values of protein content in Table II are in accord with the stabilization effect as observed by Richmond and Lang.<sup>1</sup> The above similar value of soluble nitrogen in water-cultured discs as in kinetin in Expt. 1 is due to leaching out of the soluble nitrogenous substances and probably also to rapid oxidation which ensues in collapsing cells.

The results clearly indicate that the physiological age of the leaf may be a controlling factor in the kinetin-regulated protein level in isolated leaf parts.

The reasons for the age effect are unknown however and could be due to differences in the endogenous sugar levels<sup>3</sup> or differences in the "response" of different protein fractions to kinetin which undergo important changes with ageing.<sup>6-8</sup>

Botany Department, D. BANERJI.  
University of Allahabad, M. M. LALORAYA.  
India, March 18, 1963.

1. Richmond, A. E. and Lang, A., *Science*, 1957, **125**, 650.

TABLE II

Changes in the protein and soluble nitrogen content in leaf discs from flowering plants  
mg.-N/5 discs (Diameter 2.4 cm.)

Expt. No.	Initial		3 days		5 days	
	Protein † a/b	nitrogen Sol. N a/b	Kinetin P/S†	Water P/S	Kinetin P/S	Water P/S
1	10.8/10.7	1.1/1.2	..	..	9.7/1.7	6.7/1.8
2	11.3/..	1.2/1.2	10.4/0.5	9.3/0.8	.. /0.5	7.1/1.1

\* Leaf discs for initial analyses and those of experimental at 3 and 5 days were from different leaves but the discs at any one period for kinetin and water culture were from two halves of a single leaf.

† a/b two halves of a leaf.

P/S Protein nitrogen/Soluble nitrogen.

Tables I and II show the result of these experiments. It will be seen that protein breakdown took place both in discs floated in kinetin solution and in water to about the same extent in discs obtained from leaves of vegetatively growing plants. Although the leaf closest to the apex is high in protein, and the value falls with increasing node number down from the apex, the degree of protein breakdown is about the same, ranging between

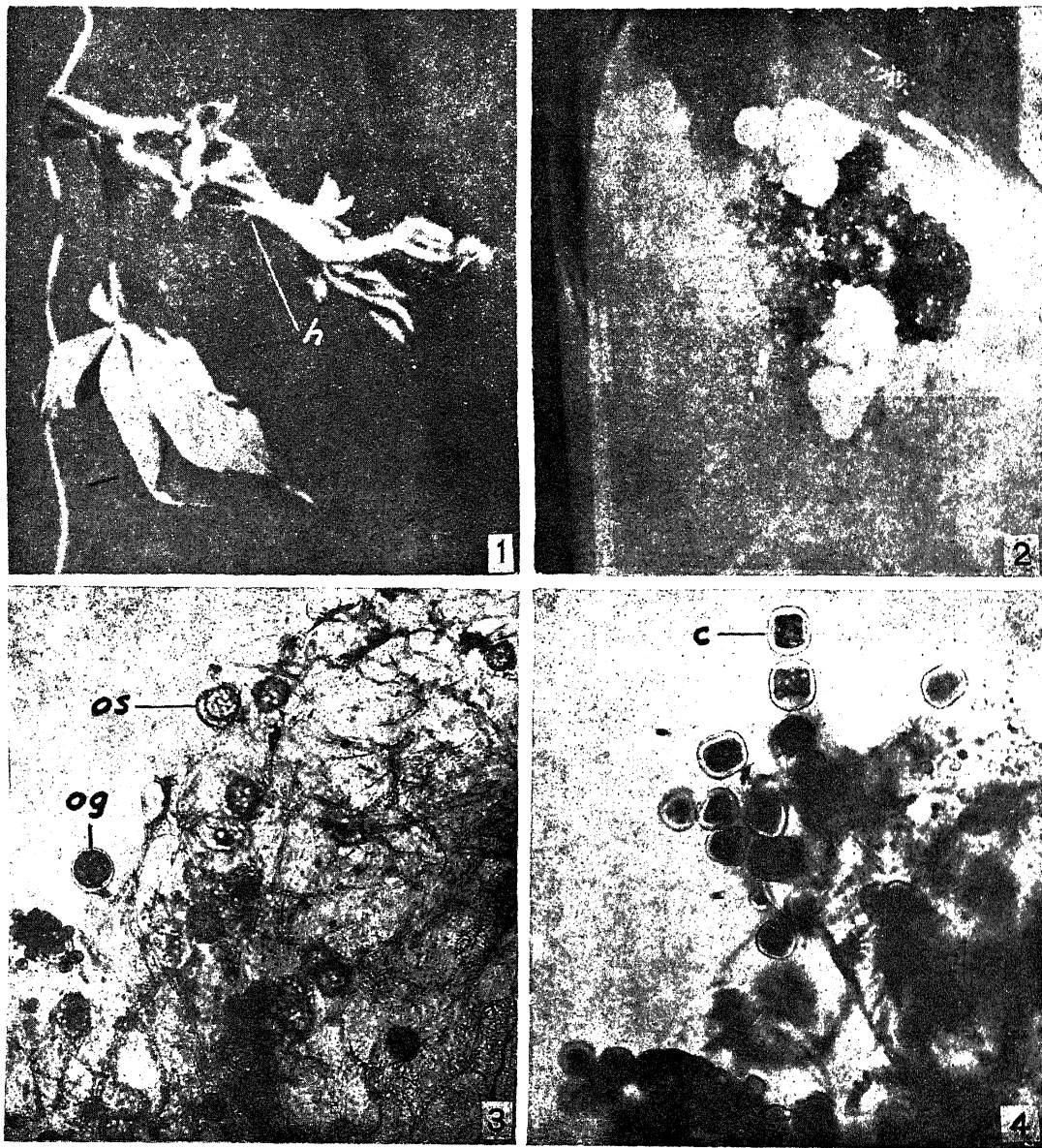
2. Mothes, K., *Naturwissenschaften*, 1960, **47**, 337.
3. Sugiura, M., Umemura, K. and Oata, T., *Physiologia Plant.*, 1962, **15**, 457.
4. Parthier, B. and Wollgiehn, R., *Ber. dtsch. Bot. Ges.*, 1961, **74**, 47.
5. Thimann, K. V. and Laloraya, M. M., *Physiologia Plant.*, 1960, **13**, 165.
6. Dörner, R. W., Kahn, A. and Wildman, S. G., *J. biol. Chem.*, 1957, **229**, 945.
7. Zucker, M., *Plant Physiol.*, 1959, **34**, 563.
8. Nitsan, J., *Ibid.*, 1962, **37**, 291.



# THE GROWTH OF *ALBUGO* IN THE CALLUS CULTURE OF *IPOMOEA*

ONE of the greatest handicaps in many kinds of studies with obligate parasites is the difficulty of maintaining axenic cultures. Several attempts have been made to grow these organisms on synthetic media but positive results

have been achieved only in recent years.<sup>2-4,6</sup> In their cultures of the infected tissue of the host, Hotson and Cutter<sup>6</sup> and Cutter<sup>2-4</sup> observed that occasionally the fungus began to grow directly on the medium. However, these findings have been variously criticized<sup>1,9</sup> and remain unconfirmed by other workers.



FIGS. 1-4. Fig. 1. Stem of *Ipomoea pentaphylla* bearing a side shoot which is hypertrophied due to infection with *Albugo ipomoeae-panduratae*. Fig. 2. Callus obtained by inoculating a portion of the pith and cortex of the gall; note the brown globules in the centre and white ones at the periphery. Figs. 3-4. Sections of the white spherules showing oospores and conidia; an unfertilised oogonium is seen on the surface of the callus in Fig. 3. Key: c, conidium; h, hypertrophied shoot; og, oogonium; os, oospore.



A few obligate parasites belonging to the families Peronosporaceae,<sup>7</sup> Erysiphaceae,<sup>5</sup> Pucciniaceae<sup>8</sup> and Melamporaceae<sup>10</sup> have been cultivated on a tissue culture of their hosts, but so far there is no report of the growth of a member of the Albuginaceae in the dual organism culture.

Several species of *Ipomoea* at Delhi become infected with *Albugo* during the rainy season (August, September). In *I. pentaphylla* the stems, petioles and flowers become hypertrophied to form a gall (Fig. 1) which is systemically infected with *A. ipomoeae-panduratae*. Following the techniques of Morel<sup>7</sup> small portions of the pith and cortex of these galls were at first inoculated on a basic agar medium containing half-strength Knop's solution, 2% sucrose, vitamins and Burkholder and Nickell's trace elements' solution. These explants turned brown after a few days but by supplementing the medium with coconut milk (15%), kinetin (1 ppm), IAA (1 ppm), casein hydrolysate (200 ppm) and ascorbic acid (5 ppm) it was possible to cause the gall tissue to proliferate and form a callus which has now been maintained for more than a year. The callus grows in the form of small groups of parenchymatous cells with xylem tracheids in the centre. In two cultures short roots grew out of these masses. The young callus spheres are snow-white but the older portions turn brown and die (Fig. 2). If the callus was kept on the same medium for more than two months the whole of it turned brown. The young snow-white globules were, therefore, subcultured at intervals of less than two months.

In about 30% of the cultures, after they had been growing for 40 days on a fresh medium, the white globules showed numerous long chains of conidia coming out of the surface. The chains have a tendency to become dislocated during section-cutting but this is not unexpected. A histological examination showed a coenocytic mycelium freely proliferating in the intercellular spaces in the callus in about 80% of the culture tubes. Small round haustoria were present in abundance inside the host cells. The tips of many of the hyphae reached the surface of the callus and produced a small aerial mycelium. More often they were swollen and bore chains of conidia separated by disjunctors in a manner which is typical of *Albugo* (Fig. 4). About 60% of the cultures showed an abundance of oospores which fully resembled those occurring in Nature. Unfertilised oogonia were also observed at the surface of the callus (Fig. 3).

For the first three weeks after inoculation on a fresh medium a callus with oospores grows at a much faster rate, as compared to the one without them. In about 20% of the cultures the fungus showed only the vegetative phase.

It was observed that some of the explants became free of the fungus after repeated subculturing. Such a callus could be easily distinguished from the infected callus. While this has snow-white globules which later turn brown, the fungus-free callus is uniformly greenish or yellow.

Department of Botany,  
University of Delhi,  
Delhi-6, India, June 13, 1963.

HARDEV SINGH.

1. Allen, P. J., *Annual Rev. Pl. Physiol.*, 1954, **5**, 225.
2. Cutter, V. M. Jr., *Trans. N.Y. Acad. Sci.*, 1951, **14**, 103.
3. —, *Mycologia*, 1959, **51**, 248.
4. —, *Ibid.*, 1960, **52**, 726.
5. Heim, J. M. and Gries, G. A., *Phytopath.*, 1953, **43**, 343.
6. Hotson, H. H. and Cutter, V. M. Jr., *Proc. Nat. Acad. Sci., U.S.A.*, 1951, **37**, 400.
7. Morel, G., *Ann. Epiphyt.*, 1948, **14** (N.S.), 1.
8. Nozzolili, C. and Craigie, J. H., *Canad. J. Bot.*, 1960, **38**, 227.
9. Savile, D. B. O., *Ibid.*, 1955, **33**, 60.
10. Turel, F. I. M. and Le'dingham, G. A., *Canad. J. Microbiol.*, 1957, **3**, 813.

#### A NEW SPECIES OF *DENDROGRAPHIUM* FROM INDIA

THIS interesting but rare hyphomycetous fungus was collected during the rainy season of 1962 at the law college campus, Poona, growing saprophytically on dead twigs of an unidentified host. The fungus formed powdery black coating over the surface of the twigs which, on microscopic examination, revealed the presence of abundant synnemata and septate, vermiculate conidia formed in chains over knee-like dark-brown conidiophores. These characters confirmed the fungus to belong to the genus *Dendrographium* Massee.

The genus *Dendrographium* was established by Massee (Saccardo, 1895), with *D. atrum* Massee as type.<sup>1</sup> A critical study of literature showed that only three valid species of *Dendrographium* have been so far described, two of which are Indian in origin. The Poona collection was, therefore, compared with the three known species with the following results (Table I).

The Poona collection is presented as a new species with the following Latin diagnosis:

TABLE I  
Comparison between species of *Dendrographium*

Species	Synnemata in $\mu$	Conidia in $\mu$	Authority
<i>Dendrographium atrum</i> Massee	..	7-Septate 40-50 $\times$ 5-6	Massee*
<i>D. Mitteri</i> Syd.	.. 170-250 $\times$ 40-80	3-10-Septate 35-110 $\times$ 7-12	Sydow and Mitter (1933) <sup>2</sup>
<i>D. interseminatum</i> Subram.	.. 350-730 tall	3-Septate, verrucose 21-25 $\times$ 5-6-7	Subramanian (1956) <sup>2</sup>
Poona Sp.	.. 210-637 $\times$ 42-127 $\cdot$ 4	3-14-Septate, smooth 50.4-160 $\times$ 8.4-13.65	Author

\* Less quoted from Saccardo.<sup>1</sup>

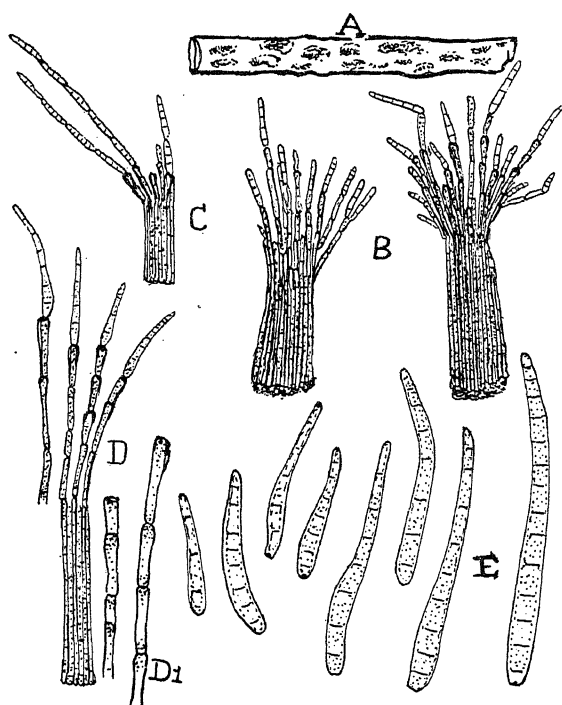


FIG. 1. A. Habit. B. Synnemata,  $\times$  60. C. Conidia in chains,  $\times$  60. D. Mycelium, conidiophores and conidia,  $\times$  100. D1. Conidiophores,  $\times$  264. E. Conidia,  $\times$  264.

*Dendrographium kamatii* VASANT RAO, SPEC. NOV.

Coloniæ nigræ, dispersæ, pulverulentæ, fasciculatæ. Synnemata erecta vel curvata, eminentia, distincta vel gregaria, fuscè brunnea 210-637  $\times$  42-127  $\cdot$  4  $\mu$ . Conidiophori simplices raro ramosi, pallide brunnei, septati, constricti genus instar 71.4-210  $\times$  5.25-7.35  $\mu$ , efformati in corona expansa capitata, divergentes, cicatricibus ornati. Conidia vermiculata vel elongato-obclavata, nonnulla curvata, basi plana,

fastigata et rotundata ad apicem, 3-14-septata, non-constricta ad septa, parietibus duplicibus, levia, pallide brunnea, in catenas breves 2-4 disposita 50.4-160  $\times$  8.4-13.65  $\mu$ .

Saprophytice inficit surculos emortuos *Vitis crinoides*. Leg. Vasant Rao, aug. 1962, Poona, in India, M.A.C.S. Mycol. Herb. 153.

The species has been described after Prof M. N. Kamat in recognition of his valuable contributions to Indian Mycology and Plant Pathology.

The type specimens are being deposited at the Herb. Crypt. Orientalis, New Delhi (India), and Herb. C.M.I., Kew, Surrey, England

M.A.C.S. Labs., VASANT GURUNATH RAO.  
Poona-4, January 24, 1963.

1. Saccardo, P. A., *Sylloge Fungorum*, 1895, **11**, 644.
2. Subramanian, C. V., *J. Indian bot. Soc.*, 1956, **35** (4), 471.
3. Sydow, A. H. and Mitter, J. H., *Ann. Mycol.*, 1933, **31**, 96.

#### BACTERIAL LEAF BLIGHT OF CASTOR BEANS

THE castor bean (*Ricinus communis* L.) crop of the research farm of the Institute of Agriculture, Anand, Gujarat, India, suffered from a devastating blight disease during September 1960. Since the brownish spots appear at the tips of the leaves in early stage of disease development, it seems probable that the organism gains entry through the hydathodes (Fig. 1, a). The infection then proceeds through the veins towards the centre of the leaf, resulting in blighting of the entire leaf. The veins and leaf become dark brown and die (Fig. 1, b and c). A gummy, shining ooze in the form of a thin film, appears on both surfaces of the infected

leaf, it does not form on infected petiole or stem. The organism travels through the xylem vessels, much as in black rot of crucifers, and then proceeds into the petiole and stem. If disease development is severe, the stem may break (Fig. 1, d). Unsparing blight occurs when the seedlings are infected (Fig. 1, e and f).

The microscopic examination of affected tissues revealed bacteria oozing out mainly from the veins in the early stage and from other tissue cells in the advanced stage of disease development.

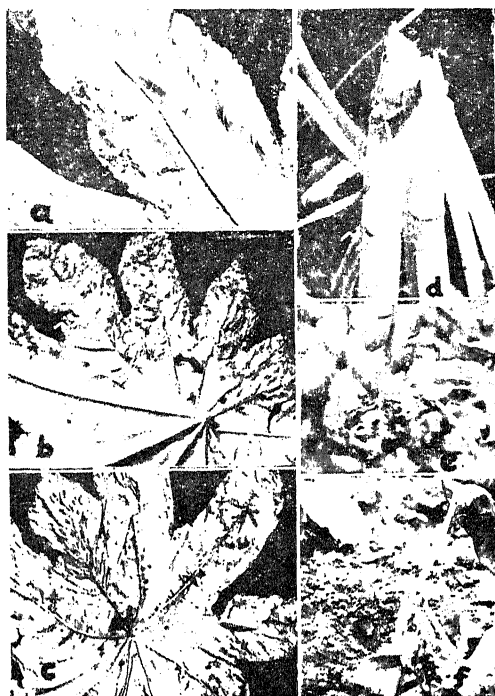


FIG. 1. Stages of bacterial leaf blight of castor bean. a, Early stage of infection-entry through hydathodes and then proceeding through the veins. b, Advance stage of disease development. c, Extreme stage of disease-complete blighting of the leaf and the organism proceeding to the petiole. d, Stem-break. e, Blighted cotyledons. f, Severe blight of the castor bean seedling.

Yellow shining isolates obtained on potato dextrose agar were purified and used as inoculum for pathogenicity tests. When placed on

injured leaf tissues, the inoculum began developing disease from veins within 7 to 10 days after inoculation. When the inoculum was sprayed on uninjured healthy leaves, the disease developed only on tips of leaves. No spots developed. This indicates that the organism enters the host tissue either through wounds or through hydathodes.

The organism is a short rod with rounded ends, gram-negative and measures  $1.23-1.53 \mu \times 0.53-0.85 \mu$ . Colonies on potato dextrose agar are citron yellow (R), circular with entire margins, smooth, convex, glistening and butyrous; odour absent and colour of the medium unchanged. These characters indicate that the organism belongs to the genus *Xanthomonas*.

The organism incited the blight disease only on the leaves of *Ricinus communis* L., *Brassica oleracea capitata* L., *Cassia tora* L., *Crotalaria juncea* L., *Cyamopsis tetragonoloba* (L.) Taub., *Dolichos lablad* L., *Gossypium arboreum* L., *G. hirsutum* L., *Linum usitatissimum* L., *Phaseolus aconitifolius* Jacq., *P. vulgaris* L., and *Sesbania cegyptiaca* Poir were not affected.

Patel et al.<sup>1</sup> have reported that *Xanthomonas ricinicola* (Elliot) Dowson produces few to numerous, small rounded, water-soaked spots mostly aggregated toward the tips of the leaves of castor beans. Consequently, it is inferred that *X. ricinicola* does not develop blight of castor bean leaves. Since the organism reported here develops only blight symptoms and not leaf-spot, it is different from *X. ricinicola* reported by Patel et al., and thus new to the science. It is, therefore, proposed to name it as *Xanthomonas anandensis* species novum after Anand from where this organism has been discovered.

The authors are thankful to Rev. Father H. Santapau, Chief Botanist, Botanical Survey of India, for suggesting the name and to Dr. M. K. Patel for helpful suggestions.

Institute of Agriculture,  
Anand, April 17, 1963.

M. V. DESAI.  
H. M. SHAH.

1. Patel, M. K., Kulkarni, V. S. and Dhande, G. W., "Bacterial leaf-spot of castor," *Curr. Sci.*, 1951, 20, 20.

## REVIEWS

**Ordinary Differential Equations.** By L. S. Pontryagin. Translated from Russian by Leonas Kacinskas and Walter B. Counts. (Addison-Wesley Publishing Company, Inc., Reading, Mass.), 1962. Pp. 298. \$ 7.50.

The book under review consists of the following six chapters: (1) Introduction, (2) Linear Equations with Constant Coefficients, (3) Linear Equations with Variable Coefficients, (4) Existence Theorems, (5) Stability and (6) Linear Algebra.

Professor Pontryagin is one of the top pure mathematicians of the world who is well acquainted with many branches of applied mathematics. On the one hand, therefore, the book is written with the rigour of pure mathematics giving all the necessary conditions and specifying domain for the validity of each theorem, and on the other hand the illustrative examples are drawn from practical problems from diverse fields of applied mathematics like theory of oscillation and automatic control. The book does not collect the usual methods of solving differential equations but takes the reader to the deeper understanding of the subject and lays considerable emphasis on the existence and stability of solutions.

The presentation of the subject-matter is clear and lucid and a serious student of mathematics will be highly benefited by reading it. The reviewer has great pleasure in recording that it is a very welcome addition to the existing list of books on Differential Equations.

P. L. BHATNAGAR.

**Modern Multidimensional Calculus.** By M. E. Munroe. (Addison-Wesley Publishing Co., Mass., U.S.A.), 1963. Pp. ix + 389. Price \$ 6.50.

Under a rather unusual title this is a text-book on Calculus a little above the standard of the Indian B.Sc. and below that of the M.Sc. courses. In addition to classical topics: differentiation and integration—multiple integrals being naturally included—one finds a short but good introduction to Linear Algebra and to Vector Differential Calculus. The chapters devoted to such topics are the best of the book and accompanied by a number of well-chosen examples. The analytical part, namely that dealing with abstract notions: functions, differentials, etc... is not of the same quality. The author aims at

rigour and precision; this is laudable. But he is often unnecessarily verbose and complicated. It is surprising that a book of this type should assume, without any care to define it, the notion of limit. In spite of its defects this text may provide Mathematics lecturers with new ideas to improve and modernize their lectures.

C. RACINE.

**Physical Methods in Heterocyclic Chemistry** (Vols. I and II). Edited by A. R. Katritzky. (Academic Press, New York), 1963. Pp. xi + 346; xi + 398. Price \$ 12 and \$ 14.

In the vast and varied field of heterocyclic chemistry, several workers have applied physical methods both for the study of various systems and correlation of different structures. The systems being innumerable, and heterocyclic chemistry having grown haphazardly, there data are scattered far and wide in the literature; several reviews have been published but information in these too are not well correlated.

In these two volumes Prof. Katritzky has brought all the information together and presented them in a neat and orderly manner in ten chapters. Each chapter, written by an expert in the field, starts with an introduction to the principles and experimental methods of determining the various physical factors, followed by a detailed and lucid study of the applications and correlations to various heterocyclic compounds. A large number of references are given at the end of each section, the authors having collected the literature upto the beginning of 1962.

The first volume discusses the non-spectroscopic methods, the ionization constants, X-ray diffraction studies, solubility, dipole moments and electrochemical properties in solution of heterocyclic compounds. It also includes a section (section 2) on 'Heteroaromatic Reactivity' which gives the data from mechanistic studies and theoretical calculations. Volume II deals with the spectroscopic methods—electronic absorption spectra, nuclear quadrupole resonance, nuclear magnetic resonance spectra and infrared spectra of heterocyclic systems.

There is little doubt that this will be a standard reference book to all workers in the field of heterocyclic and also physical organic chemistry and in a few years will be found in every library.

G. B.

**Enzyme Histochemistry and Its Application in the Study of Neoplasms.** By M. S. Burstone. National Cancer Institute, National Institutes of Health, Bethesda. (Academic Press, New York and London), 1963. Pp. xiv + 621. Price \$22.50.

The biochemist has steadily improved upon diverse techniques of experimentation and there has been spectacular progress in our understanding of the enzymatic mechanisms that determine and control the metabolism and vital activity of cells and thus of the organism. One source of error that has been pointed out in the biochemical approaches to study of enzyme function is the disturbance in the structural organization that results from cell rupture preceding enzymatic assays. Aware of this shortcoming, the biochemist has endeavoured to overcome it and has indeed succeeded in more or less reconstructing the events in the intact cell from observations with isolated cell fractions. Nevertheless, definitive histochemical techniques which utilise tissue sections, the architecture of which is not grossly disturbed, have been of value in more precisely localising, by certain known chemical reactions, the cytological sites associated with specific enzyme activities. Such microscopic techniques have also been quantitated by ingenious means and have, therefore, added chemical significance to the morphologic information which the pathologist and histologist secure in their routine diagnostic procedures. The fact that disease essentially manifests itself as a disorder, inhibition or hyper-function of enzymes, would underscore the significance of enzyme histochemistry in solving problems of diagnostic pathology.

The text gives exhaustive coverage to this relatively new subject to which the author has himself made noteworthy contributions. Dr. Burstone has ably indicated all the essentials of organic chemistry, biochemistry and morphology upon which the various methods are based. Apart from the basic chemistry involved, the format of the book includes for each chapter details relating to specific laboratory procedures for synthesis of various substrates and allied compounds and for demonstration and appraisal of enzymes. Extensive tabular data enumerate molecular structure and other chemical characteristics of intermediates and compounds which either have been applied in enzyme histochemistry or biochemistry or else may have potential application with reference to new substrate design.

Although written with particular reference to the metabolic alterations that occur concomitantly with neoplastic processes, the book provides ample scope to an appreciation of the extent to which application of histochemical techniques would aid in our understanding of a variety of non-neoplastic pathological conditions as well. Two chapters deal with histochemical techniques of enzyme study at the electron microscope level or after electrophoretic separation procedures.

This most authoritative monograph will be of immense value to all those concerned with researches on the application of histochemical techniques to the study of alterations in enzyme systems associated with physiological processes or pathological states.

A. S.

---

**Advances in Clinical Chemistry, Vol. V (1962).** Edited by H. Sobotka and C. P. Stewart. (Academic Press, New York and London), 1963. Pp. xiv + 329. Price \$12.00.

This volume, the fifth in the series, presents comprehensive reviews on six topics covering diversified subjects of interest to geneticists, biochemists and clinicians.

Galactosemia is an inborn error of metabolism. The genetics of galactosemia, clinical manifestations, the biochemical basis for this disorder, experimental induction and many other facets of this interesting and widespread disease have been covered in this review.

'Malabsorption syndrome' presents the specific features of this syndrome and reviews the role of wheat gluten in the pathogenesis of this 'sprue'-like syndrome. Peptides, possibly glycopeptides, fractionated from wheat gluten have been shown to be the toxic factors and their pharmacological effects have been partly defined.

Peptidiuria is now established as a physiological phenomenon. The present status of our knowledge on the peptides in normal and pathological urine and its usefulness in clinical medicine has been reviewed.

Haptoglobins are plasma proteins reacting stoichiometrically at physiological pH with Hb and globin, with the formation of stable complexes and with essentially the same antigenic structure within each species.

The review on Haptoglobins presents in detail the isolation and characterization of these plasma proteins, the importance of these genetically controlled haptoglobins of man in

forensic medicine, their probable role in health and disease and their significant contributions to the study of 'genetic control of protein synthesis'.

"The Microbiological Assay Methods" deal comprehensively with the assay techniques of the B-complex group of vitamins.

A few of the dehydrogenases that are of importance for diagnostic, prognostic or as therapy-controlling tools and known to be etiological factors of pathological states have been reviewed.

Attention is focussed on the dehydrogenases, G-6-PDH and 6-PGDH; Glutathione reductase; Methemoglobin reductase and sorbitol (polyol) dehydrogenases which are known to be specifically involved in certain clinical disorders.

M. SIRSI.

#### Human Nutrition and Dietetics (2nd Edition).

By Sir Stanley Davidson and R. Passmore. (E & S Livingstone Ltd., Edinburgh and London), 1963. Pp. xii + 887. Price 90 sh.

This comprehensive treatise on 'Human Nutrition and Dietetics' was first published in 1959. During the last 4 years this book has been quite popular as a text-book for undergraduate and postgraduate students of nutrition. In the second edition, the authors have made a thorough revision of the text and have added two new chapters, namely (1) Inborn errors of metabolism and (2) Nutrition and care of the aged.

This book has the unique distinction of dealing with several aspects of the subject of human nutrition and dietetics. The authors have included in the second edition all the recent advances in this field. The book is well produced and includes select bibliography and a good subject index. The revised edition will be widely welcomed by all students of nutrition and dietetics and also by postgraduate medical students. This volume will serve as a valuable reference manual and source book to all research workers in nutrition and dietetics and also to clinicians.

M. SWAMINATHAN.

**International Review of Cytology.** Eds. G. H. Bourne and J. F. Danielli. (Academic Press, Inc., New York and London), Vol. 13: 1962. Pp. v + 393. Price \$15.00; Vol. 14: 1963. Pp. ix + 414. Price \$16.00.

Catering, as they do, to a wide variety of tastes and specialization, the two volumes contain the following review articles: Vol. 13—

Cytochemistry of Protozoa, Cell Renewal, Chromosomes Reproduction, Chromosome Aberrations, Sequential Gene Action and Cellular Differentiation, Mitochondrial Membranes, Metabolic Pathways in Erythrocytes, Alkali Cation Transport and Coding Hypothesis; Vol. 14—Mast Cell, Experimental Inhibition of Cell Division, A Cytochemical Theory of Hearing, Cell Walls, Electron Microscopy of Plant Protoplasm, Development of Drug Resistance in Staphylococci, Connective Tissue and Serum Proteins and Nucleic Acids.

The review on "Chromosome Aberrations Induced by Ionizing Radiations" by Evans is worth attention. The Coding Hypothesis by Yeas reflects some of the recent advances in the rapidly developing field of Molecular Genetics. The presentation of the problem from a historical perspective is attractive.

Cigarette smoke and viruses have been known to cause tumours in man. Inhalation of cigarette smoke by experimental animals cannot strictly be compared to that by humans. But animal experiments aid assessment of the damage caused. It has been known that painting the skin, and sub-cutaneous injections of smoke condensates provoke tumour development. Leuchtenberger and Leuchtenberger record that among the animals tested, only mice exhibited cellular abnormalities of varying degrees on inhalation of cigarette smoke. "The incidence of these lesions did not increase with time and dose of cigarette smoke. Cessation of inhalation of cigarette smoke led to a decrease in incidence suggesting reversibility of lesions" (Vol. 14, p. 318).

M. K. S.

**Rhizocephala.** By H. Boschma. *Discovery Rep.* XXXIII. (Issued by the National Institute of Oceanography, U.K. Cambridge University Press, London), 1962. Pp. 55-94. Price £2-2-0 net.

This account by Boschma deals with the Crustacean parasites in the *Discovery* collections belonging to the Rhizocephala, viz., *Briarosaccus callosus* Boschma, originally described from a Lithodid crab by the author. A detailed description of the type specimen—peculiarities of the external appearance, its internal structure, and of the chitinous layers of the outer and inner surface of the mantle—is given some errors in the earlier account corrected and much information added. 15 specimens on the crab *Lithodes* and five on the crab *Paralonis* are

described which give one the impression of the variation in size and in shape of the parasite. The variations are such that they are more striking between specimens from species of same host than between specimens from different hosts. Because of lack of constant specific characters all the specimens examined are referred to *B. callosus*. This parasite infests the crabs *Lithodes agasizii* Smith in the Atlantic, *L. æquispinus* Benedict in the Bering Sea, *L. antarcticus* Jacquinot and *Paralonis granulosa* (Hombron and Jacquinot) in the Antarctic and Sub-antarctic, thus showing a wide distribution. The relationship and affinities with parasites on the other crabs are discussed. The author has also studied additional samples from *Paralonis granulosa* and *Lithodes antarcticus* to gather data on individual variation. It is concluded that as long as parasites of one species of host crab present among themselves striking differences than those found between parasites of different species of host crabs, there is no indication of specific divisions within the group, and all the parasites of the crabs of genera *Lithodes* and *Paralonis* are to be regarded as representatives of a single species; in other words, conspecific. The account is well illustrated and presented and should serve as a caution to those inclined to create new taxa.

R. SUBRAHMANYAN.

#### Soil and Freshwater Nematodes (2nd Edition).

By T. Goodey. Re-written by J. B. Goodey. (Methuen & Co., London W.C. 2), 1963. Pp. xvi + 544. Price £ 5.00.

The first edition of this book appeared in 1951. Since then, the field comprising soil and freshwater nematodes has tremendously increased, mainly because of the description of the numerous genera and species. The present edition incorporates the latest information on the nematodes of this vast group.

The book opens with an introduction outlining the plan, technique, and general structure of a nematode. This is followed by a short tabular classification of the nematodes covered in the book. These include the nematodes belonging to 10 different Orders (including 46 Families), viz., Tylenchida, Rhabditida, Teratocephalida (newly proposed), Aræolaimida, Desmoscolecida, Monhysterida, Chromadorida, Enoplida, Dorylaimida and Trichosyringida (newly proposed). Various categories from Orders to Genera are then elaborately defined. Almost all the genera are adequately described with greater details on

their types. In case where the type is insufficiently known, a reliable species has been selected as its representative. A generalized account on the bionomics of the individual genus is also given. This is followed by an up-to-date list of the nominal species in the genus. A novel feature of the present edition is the introduction of the tabular keys for the identification of the various categories from an Order down to a Genus. Although not relevant by the title, the book is a good source of information on the plant-parasitic nematodes as is hinted at by the figure of an obligate plant parasitic nematode on the cover page.

This new edition of the book is a good proof of the command which the revising author holds on the soil, plant and freshwater nematodes. The up-to-date information masterfully condensed in 544 pages is the engaging quality of the book. The way in which the classification of the nematodes is presented is highly commendable. However, at certain places the decision of the author is debatable especially when valid families and genera (like Actinolaimidæ and Longidoridæ; *Basiria*, *Hemicriconemoides* and *Cacopaurus*) are reduced to synonyms. The book is a must for every worker in the field of Agro-, Phyto- or Hydro-nematology.

M. RAFIQ SIDDIQI.

#### Directory of British Scientists. (Ernest Benn Ltd., Bouverie House, Fleet Street, London E.C. 4). Pp. xxxii + 1289.

For the purpose of this compilation a scientist has been defined as a "British" who has taken a degree in science from a British University; and it excludes those individuals who are already eligible for inclusion in the various Registers of their Professions. Even with this restriction the compilation of a Directory of about 30,000 scientists spread all over the country is not an easy one, and the Publishers and the Editors deserve congratulations on bringing out this book.

There has been a personal touch in the gathering of information given against each individual so that it is authentic and at the same time modest too. Through the help of different universities the names and the whereabouts of the scientists had been obtained, and a questionnaire was sent to each one of them for the information recorded against each, namely, present address, degree, year and the name of the university from which it was taken, position held, field of interest, and scientific

publications in brief. This forms the main part of the Directory of about 1100 pages. There is a second section of about 160 pages called the Classified Directory in which the names of the scientists are listed under 46 heads or "spheres of work". These include, besides the obvious divisions of science (physics, chemistry, mathematics, botany, zoology, etc.), such additional titles as astronautics, computer studies, cybernetics, hæmatology, operation research, etc.

There are also three shorter sections which will be of particular use to research scientists. They are: (1) A list of Scientific Societies in Britain and their Journals, with names of Secretaries; (2) Other British Scientific Periodicals with the names of their Publishers; and (3) Research Establishments in Britain.

The present volume is only a beginning, and there are bound to be omissions. Such omissions can be rectified in the next edition (1963) by writing to the Editorial Secretary, *Directory of British Scientists*, Orchard House, Caldecott Road, Abingdon, Berks. A. S. G.

#### Books Received

From: (Academic Press, 111, Fifth Avenue, New York-3, N.Y.):

*Physics of Thin Films* (Vol. I). Edited by G. Hass. 1963. Pp. xi + 350. Price \$13.00.

*Newer Methods of Nutritional Biochemistry* (with Applications and Interpretation). Edited by A. A. Albanese. 1963. Pp. xi + 583. Price \$18.50.

*Cytodifferentiation and Macromolecular Synthesis*. Edited by M. Locke. 1963. Pp. xi + 274. Price \$10.00.

*Random Vibration in Mechanical Systems*. By S. H. Crandall and W. D. Mark. 1963. Pp. x + 166. Price \$6.50.

*Introduction to the Theory of Integration—Pure and Applied Mathematics* (Vol. 13). By T. H. Hildebrandt. 1963. Pp. ix + 385. Price \$14.00.

*Origin of the Solar System*. Edited by R. Jastrow and A. G. W. Cameron. 1963. Pp. xiii + 176. Price \$8.00.

*The Enzymes* (Vol. 7)—*Oxidation-Reduction*, (Part A)—*Nicotinamide Nucleotide Flavin Nucleotide*. Edited by P. D. Boyer, H. Lardy and K. Myrback. 1963. Pp. xxi + 726. Price \$21.00; Subn. Price \$18.00.

*Ultracentrifugal Analysis in Theory and Experiment*. By J. W. Williams. 1963. Pp. xvii + 282. Price \$10.00.

*Environmental Control of Plant Growth*. Edited by L. T. Evans. 1963. Pp. xvii + 449. Price \$17.00.

*Pure and Applied Physics* (Vol. 15)—*Nuclear Research Emulsions* (Vol. I) *Techniques and Theory*. By W. H. Barkas. 1963. Pp. xvi + 518. Price \$18.00.

*Physical Techniques in Biological Research* (Vol. VI). *Electro-Physiological Methods* (Part B). Edited by W. L. Nastuk. 1963. Pp. xii + 425. Price \$14.50.

*Enzyme and Metabolic Inhibitors*. By J. Leyden Webb. 1963. Pp. xxi + 949. Price \$26.00.

*Advances in Applied Microbiology* (Vol. 5). By W. W. Umbreit. 1963. Pp. xi + 385. Price \$13.00.

*Metabolic Inhibitors—A Comprehensive Treatise* (Vol I). Edited by R. M. Hochster and J. H. Quastel. 1963. Pp. xx + 669. Price \$26.00.

#### ADVANCES IN ECOLOGICAL RESEARCH\*

THE aim of plant ecology is to understand and explain the distribution of flora in terms of the environment and the past history. It is generally agreed that vegetation is not just a chance conglomerate of species but the result of their interaction under the local ecological conditions. A particular plant community, so developed, has a definite structure and composition containing only those species out of the once available propagules of the region, which are adapted to the climatic, edaphic and biotic factors which have operated in the locality and are operating at the present time.

A detailed description of such a community is essential for a proper study of any ecological problem. The details to be collected will naturally vary with the particular objective of the investigator. The pattern of vegetation is very complex and changes with bewildering frequency in time and space and the process is not yet fully understood. Therefore, experiments are of limited usefulness. But whenever any auto- or synecological problem can be thus studied, this method can be used to test a particular hypothesis provided due care is taken to eliminate the effects of vitiating factors. But such experiments are of limited application to the actual conditions obtaining in the field. The ecologist must, therefore, use other means of investigation and reasoning to properly under-

\* *Advances in Ecological Research*, Vol. 1. Edited by J. D. Cragg. (Academic Press, London W. 1), 1962. Pp. xi + 203, Price 45 sh.



stand specific problems, namely critical observations by broad classification of data. By doing so correlation can be found and a hypothesis propounded. This can then be repeatedly checked and if necessary altered when necessary to remove inconsistencies. It is such scientific sifting of evidence to ultimately arrive at the truth which has been referred to as the method of "successive approximation" as opposed to the rigidly quantitative approach. M. E. D. Poore in his article on "The Method of Successive Approximation in Descriptive Ecology" rightly advises that the usual methods of plant classification based on various characters such as life form, chorology, etc., should be eschewed in favour of one which establishes relationship between the vegetation and its habitat. The proposed method should definitely prove to be more economical in the end.

In another article J. D. Ovington deals with the comprehensive subject of *Quantitative Ecology and the Woodland Ecosystem Concept* which has, in recent years, assumed considerable importance in the study of the silviculture and management of forests. The survey, covering 88 pages, is a masterly exposition of the present knowledge on the subject and should prove of immense use to foresters. The study of forest ecosystem is a difficult task because of the vast extent of forests and the fact that they mature on long 'rotations' with the result that the interaction of the various ecological factors changes with space and time. As a short cut, the forest ecologists have confined themselves to particular aspects of ecological problems within a limited compass. It is only recently that the geobiocenose (ecosystem or total site) concept has attracted their attention. Such oversimplification has resulted in a lack of integrated approach, which has hindered effective co-ordination of results from different localities. Hence the need for the study of forest ecosystem on a quantitative basis.

The potential use of this concept is now becoming more fully recognised to study the fundamental relationship and balance between the bio (living plants and animals) and the geo (the physical environment) in the *cenose* (a particular locality). It helps to better understand the dynamic nature of a forest on a long-term basis. It provides a sound foundation for research designed to understand the functional process of forests and the effect of these on forest productivity—direct and indirect—which is the primary object of forest management.

The study of plant biomass in a forest ecosystem in tree trunks that are removed, in felling debris and dead roots which returns the organic and inorganic matter back to the soil, is particularly important for determining how productivity could be maintained and if possible improved. The author has shown that the total oven-dry weight of the plant biomass, in the better grown, close canopied stands, provided appropriate adjustments are made for missing components, is about 300 to 350 thousand Kg./ha. at 50 years age, giving on an average an annual accretion rate of about 7 thousand Kg./ha.

It has also been shown that compared with other terrestrial communities forests are fairly efficient long-term producers of organic matter. How much of this will be economic use—such as wood—will depend to a great extent on the skill of the forester. The wood production can definitely be increased by the selection of improved strains of site-suitable species, indigenous or exotic, by better drainage, soil-working, use of fertilizers, pest control, etc. The author gives an excellent summary of the present knowledge of organic matter and energy dynamics, and circulation of water and chemical elements in the ecosystem. This article and the bibliography should prove of immense value to foresters.

L. B. Slobodkin writes on "Energy in Animal Ecology." After describing the various methods of approach he concludes that the ecological efficiency is probably of the order of magnitude of 5 to 20% and that so far there is no evidence to indicate either a taxonomic ecological or geographic variation in ecological efficiency.

The volume opens with an article by A. Macfadyan on "Soil Arthropod Sampling" giving practical advice on how to obtain efficient estimates of number of soil arthropods for, (a) exploratory work, aimed at finding what species, occur in an area, (b) community studies over a wide range of habitats, and (c) 'trophic' studies which demand a knowledge of absolute abundance, usually of relatively few species in a limited habitat; each making special demands on sampling and extraction techniques.

This publication, which has been well printed and got up, is the first of a series to be brought out, to present a comprehensive account of selected topics of ecological research so that those interested in ecology and allied sciences could obtain a balanced picture of recent developments.

K. P. SAGREIYA.

---



---

## SCIENCE NOTES AND NEWS

---



---

### Award of Research Degrees

M.S. University of Baroda has awarded the Ph.D. degree in Biochemistry to Shri M. G. Karmarkar for his thesis entitled "Fat, Protein and Amino-Acid Composition of Breast Milk in Relation to Dietary Intake".

Andhra University has awarded the D.Sc. degree in Technology to Shri M. S. Krishna for his thesis entitled "Ionic Mass Transfer in Packed Beds".

### Symposium on Nucleic Acids

A symposium on 'Nucleic Acids (Structure, Biosynthesis and Function)' will be held during 16-23 January 1964 at the Regional Research Laboratory, Hyderabad. The symposium is expected to be attended by a number of invited participants from India and abroad. The proceedings of the symposium will be published by the Council of Scientific and Industrial Research, New Delhi. Further details about the symposium may be obtained from Dr. P. M. Bhargava, Regional Research Laboratory, Hyderabad-9 (India).

### Pyrodynamics—Journal of Applied Thermal Processes

Gordon and Breach, Science Publishers, Inc., 150 Fifth Avenue, New York 11, New York, announce the publication of the new Quarterly Journal *Pyrodynamics*, the first issue of which will appear this Fall. The primary purpose of the journal is to bridge the gap between pure science and pure technology in the field of applied thermal processes. The Journal will present original research papers dealing with applied kinetic theory, thermodynamics, chemical kinetics, combustion processes, plasma science, energy conversion, etc.

### Bibliography of Indian Zoology

In the earlier years of the Zoological Survey of India it was a feature of the department's activity to issue as supplements to their Journal, the *Records of the Indian Museum*, bibliography of papers on Indian Zoology from time to time. This practice was discontinued for some reason or other after 1931. The revival of this feature with the help of the newly created Documentation Unit of the

department will be widely welcomed by zoologists in India and also elsewhere.

The first two numbers, issued for April 1963 and August 1963, contain references published in the years 1958 and 1959 respectively. Nearly a thousand references are listed in each of these numbers. Besides, they contain a brief review of progress in Zoology in India for the year concerned and also a list of new genera and species of the fauna of the Indian region described during the year.

The issues are in cyclostyled printing, foolscap size, paper bound and unpriced. They are issued by the Director, Zoological Survey of India, 34 Chittaranjan Avenue, Calcutta-12.

### A Giant Plant of *Rauvolfia serpentina*

Shri K. N. Kaul, National Botanic Gardens, Lucknow, writes :

Recently, at the invitation of an ascetic, I visited his village in Jaunpur to see a *Rauvolfia serpentina* (Sarpagandha) which had grown to a height of about 9 feet. On examination it was found to be a natural polyploid. Attempts are being made to multiply the plant by vegetative means as most of the seeds were found to be sterile. A few seedlings found growing near the mother plant have been transplanted at the National Botanic Gardens for further observations.

### Name Change for *Didymodon obtusifolius* Card. ex Dix. et P. Vard.

B. M. Wadhwa and J. N. Vohra, Botanical Survey of India, 14, Madan Street, Calcutta-13, write :

In the *Index Muscorum* 2 (D-H), 122, 1962, we find *Didymodon obtusifolius* Schkuhr and *Didymodon obtusifolius* Card. ex Dix. et P. Vard., as two distinct species based on two different types from Europe and India respectively. In the former the leaves are lanceolate from a widely ovate base, acuminate, margin distinctly involute; cells faintly papillose and almost distinct; while in the latter the leaves are ligulate from an obovate base, margin slightly involute above; cells densely and minutely papillose and obscure.

According to Article 64 of *International Code of Botanical Nomenclature* (1961 ed.) *Didymodon obtusifolius* Card. ex Dix. et P. Vard., published

in *Arch. Bot.*, 1 (8-9): 167, t. 3, f. 6, 1927, is a later homonym and therefore illegitimate and must be rejected. It does duplicate the name previously and validly published by Schkuhr in *Syll. Pl. Nov.* 2: 138, 1828.

The authors, therefore, propose a new name for *Didymodon obtusifolius* Card. ex Dix. et P. Vard., which is *Didymodon dixonii* nom. nov. The specific epithet is given after the late H. N. Dixon, who gave the description of the above-named taxon.

*Didymodon dixonii* WADHWA & VOHRA NOM. NOV.

*Didymodon obtusifolius* Card. ex Dix. et P. Vard. in *Arch. Bot.* 1 (8-9): 167, t. 3, f. 6, 1927 (non Schkuhr, 1828).

*Fusarium semitectum* Berk. and Rav. on *Anona squamosa* L. (A New Host Record)

S. S. Prasad and R. P. Verma, Department of Botany, Bihar University, Muzaffarpur, write:

*Fusarium semitectum* Berk. and Rav. was first observed in the months of December to March, 1961-62, on the living leaves of *Anona squamosa* L. The pathogenicity of the organism was established by isolating it from the infected leaves of the host and by reinoculating the same on the latter. The artificial inoculations were found to produce symptoms of the disease similar to those found in nature. The infected leaves of *Anona squamosa* L. are characterised by the appearance of greyish necrotic areas at the tips of the leaves spreading downwards along both the margins of the lamina. Occasionally isolated lesions are also seen at the leaf margins.

The conidia are subclavate and swollen in the middle. They are 3-5-septate, orange-pink in colour, measured  $23.4-31.2 \mu \times 2.6-3.9 \mu$  with an average size of  $27.4 \times 2.9 \mu$ .

*Fusarium semitectum* Berk. and Rav. has been reported on few host plants in India, but it is reported here on the leaves of *Anona squamosa* L. The specimen has been deposited in the herbaria of the Commonwealth Mycological Institute, Kew, England (No. 92927).

#### Hamycin—A New Antibiotic Produced in India

The Hindustan Antibiotics Ltd. at Pimpri, India, has discovered and put on market a new antibiotic called *Hamycin*. The credit of the discovery goes to Dr. M. J. Thirumalachar and his research associates in the Factory. *Hamycin* is a product of a new species of actinomycetous mold isolated from the soils at Pimpri, and derives its name from the golden-yellow colour of the product and the mycelium.

*Hamycin* is a heptaene antifungal antibiotic belonging to the group polyenes, and is active against a wide range of fungi and, therefore, effective against a large number of fungal infections of the skin, nails and scalp in humans. It is particularly effective in candida infections commonly called oral thrush, in children and newborn babies. The various properties of the antibiotic have been repeatedly confirmed in the successful treatment of numerous clinical cases and in carefully controlled experiments carried out at the Sassoon group of hospitals in Poona.

Currently *Hamycin* is being released to the market in two formulations as insertion tablets and glycerine suspension.—(News release from the Hindustan Antibiotics Ltd., Pimpri, Poona).

#### Oscillations in Magnetostriction

In a note to *Physics Letters* B. S. Chandra-secukhar has pointed out that the quantisation of the electronic energy levels in a magnetic field which leads to the De Haas-Van Alphen effect also produces an oscillatory magnetostriction in metals and semimetals. Such an oscillatory magnetostriction not only provides an interesting new technique for the study of the electronic structure of such metals and semimetals, but also can play a vital role, hitherto overlooked, in the analysis of other oscillatory phenomena such as oscillations of acoustic velocity in a magnetic field.

There has been so far a paucity of magnetostriction experiments, particularly at low temperatures, on non-ferromagnetic materials. However there exist some good data, even though not at temperatures of interest for the present purpose, for that classic De Haas-Van Alphen element bismuth. These are the excellent measurements of Kapitza on the magnetostriction of single crystals of bismuth down to 87° K. An analysis of these data indicates that a fruitful search for observing the magnetostriction oscillations will be to study bismuth at liquid helium temperatures; and quantitative measurements are possible with the improved modern techniques.—(*Physics Letters*, 1963, 6, 27.)

#### Synthesis of Adenine

Adenine is one of the four repeating subunits of the nucleic acids DNA and RNA. It is also a sub unit of compounds involved in the energy-yielding reactions of the cell, namely adenosine triphosphate (ATP), triphosphopyridine nucleotide (TPN) and coenzyme A. Because of its importance as a key constituent of the genetic

material the synthesis of adenine has been attracting interest among the scientists. Recently a group of workers at the University of California, Berkeley, have reported their success in this experiment. The compound has been synthesized by bombarding a mixture of gases with electrons from a 4.5 million volt linear accelerator. The gaseous mixture irradiated contained methane, ammonia, hydrogen and water vapour—all gases believed to be present in the primitive atmosphere. Chromatographic and other analytical techniques confirmed the appearance of adenine in the irradiated mixture. This result of formation of a genetically important molecule from original atmospheric gases of the primitive earth is significant in that it fills a gap in our efforts to reconstruct the origin of life.—(*Scientific American* : August 1963, p. 521.)

#### Interplanetary Magnetic Fields and Comet Tails

It has been generally recognized recently that the historic explanation that comet tails are formed as a result of solar radiation pressure is inadequate. Solar light pressure has been found to be insufficient by several orders of magnitude. Also processes like Coulomb collisions or acceleration coupled with charge transfer by protons in the solar wind are grossly insufficient to account for comet tails streaming within a cylinder of small diameter and great length away from the sun. In a communication to *Nature* (August 10, 1963), D. B. Beard and M. P. Nakada of the National Aeronautics and Space Administration, have pointed out the role of the interplanetary magnetic field in coupling the cometary gas to the solar wind.

A comet head may be regarded as a densely ionized plasma essentially stationary in a high-pressure solar wind containing a low-pressure magnetic field moving with wind. The stream pressure of the solar wind is the overwhelmingly dominant pressure in space, being two orders of magnitude larger than the free space magnetic pressure. Hence, the interplanetary

magnetic field is compressed against any obstacle such as the stationary plasma provided by the comet coma. This increases the magnetic pressure to approximate equality with the stream pressure. If the interplanetary field is parallel to the solar wind velocity, the compressed field tails off parallel to the solar wind in a cylindrical shape for a large distance downstream from comet coma confining the comet plasma within this volume.—(*Nature*, 1963, 199, 580.)

#### Indian Beetles to be Used to Destroy Australian Plant Pest

Noogoora burr (*Xanthium chinense*) is a destructive plant, with a detachable spiny growth, which has grown wild in Australia and causes great damage to her wool industry. The burr, which is indigenous to North America, is supposed to have been introduced into Australia with cotton-seed. It is poisonous in the seedling stage and has caused mortality among sheep, cattle and pigs, but the nature of the toxin is not yet understood. The mature growth tangles in wool and depreciates the value of the chip.

According to Mr. J. Mann, Director of the Biological Section of the Queensland Lands Department, tests, under caged conditions, conducted during the years since 1957, have shown that the Indian beetle *Nupferha antennata* will be an effective remedy against this plant pest. *Nupferha antennata* is a stem-boring beetle which destroys the burr, or reduces it sufficiently to enable control methods to become effective.

20,000 beetles will be imported from India as larvae in the roots of Noogoora burr, and held under quarantine in the Queensland Lands Department's biological laboratories pending their emergence in the summer of 1964 when they will be released in the field following permission by the Federal Department of Health. This Project is regarded as a positive approach to tackle the problem of Noogoora burr.—(*Australian News and Information*.)

# ADAMANTANE AND ITS HOMOLOGUES

STANISLAV LANDA

*Institute of Chemical Technology, Prague (Czechoslovakia)*

It is indeed a very difficult task to ascertain the individual hydrocarbons which are present in crude oils, and whose boiling points are above 200° C. It may be pointed out that even attaining the 200° C. boiling range and ascertaining the individual composition of petrol has needed about forty years of research by highly qualified workers in this field of study. With the rising boiling points of crude oil fractions there occurs the possibility of not only an increase in the number of isomers present but also, simultaneously, a decrease in the differences in the physical properties of the isomers or their homologues. Thus the difficulties of their separation as well as their identification substantially increase. Moreover, it is possible that there may be present new groups of hydrocarbons which have not been found in the lower boiling fractions, or even hydrocarbons with hitherto completely unknown structures and properties. As an example I would like to quote the crude oil of Hodonin the composition of which I began to study thirty years ago. The crude oil of Hodonin is a very heavy crude oil which does not contain petrol at all and is very viscous (119 cSt/20° and 25 cSt/50°).

Crude oils of similar character occur frequently, as can be seen from technical data quoted in literature. It may be presumed that some of the crude oils of Louisiana described by Coates, Best and Mahery may belong also to the same group of crude oils.

In the crude oil of Hodonin I, together with V. Machacek, found a quite new hydrocarbon, adamantane, the fundamental member of a new series of hydrocarbons. The isolation of adamantane consisted in thoroughly rectifying the fraction of crude oil

which is obtained by steam distillation, and freezing out. Adamantane separates out in beautiful octahedral crystals.

Adamantane is a hydrocarbon of formula  $C_{10}H_{16}$ . The carbon atoms are arranged in the same way as the carbon atoms in a diamond molecule. We could imagine that adamantane could be formed by the hydrogenation of the diamond or that the diamond could be formed by the dehydrogenation of the adamantane. It is of interest that the American scientist Bridgewater tried to obtain diamond by dehydrogenation of adamantane under high pressure. Adamantane is a compound interesting not only as regards its structure but also its properties. From the molecule of adamantane shown by means of a Stuart model it can be seen that four cyclohexane rings in saddle forms are bound together in such a manner that they form a very rigid spherical system. This symmetry becomes evident from the fact that among the 200 compounds of the formula  $C_{10}H_{16}$  only camphen, tricyclane and bornylane are solids melting at 53°, 68° and 98°, respectively, while the octahedrals of adamantane melt at 271° C. This high melting point is caused by the very rigid system of four cyclohexane rings which needs for melting a considerable quantity of heat energy for the transformation of the crystals to liquid. The spherical form of the molecule is characterized by a very small surface of the molecule. The forces binding the lattices together in the crystal are so feeble that the molecules can easily pass from the solid to the vapor state. Therefore, adamantane sublimes easily and the melting point can be determined in a sealed tube only.

If only adamantane were present in crude oil, its presence would be of significance only

as a curiosity. The relatively small quantity of adamantane in crude oil could hardly explain the special properties of some crude oils, especially of the crude oil of Hodonin: boiling point 239°, only 4% up to 250° and unusually low flash points of the heaviest oil fractions. It is worthy to mention that by means of water vapor at 100° it is possible to distil 30% of distillate from this crude oil. Therefore, as early as 1932, I presumed the presence of the homologues of adamantane in this crude oil.

The fact that, e.g., in Oklahoma crude oil only 0.05% of cyclopentane together with 22% of homologues of cyclopentane were found supports the presumption of the presence of homologues of adamantane to a higher extent.

In order to prove the presence of the homologues of adamantane, it was necessary to synthesize them and to determine their properties, because the known methods of isolation gave no hope in the successful isolation of the individual homologues of adamantane, the more so because the properties of the homologues of adamantane could not even be guessed at. The stated syntheses could have been accomplished after the Second World War only. In the meantime V. Prelog and Seivert succeeded in preparing adamantane from the malonic methylester in a yield sufficient to compare the melting point with the values found by us in the year 1932.

We began to prepare the homologues of adamantane by two methods:

Monotopic homologues were prepared from adamantane isolated from crude oil, whereas the di- and tetratopic homologues were synthesized from the methylester of malonic acid by a tedious method applied by Böttger for the adamantane derivatives, and also by Prelog for adamantane itself. We have improved this method in such a manner that the quantities obtained have been sufficient

for the determination of the essential (fundamental) data of the homologues.

Adamantane can be easily converted with yields up to 90% to bromoadamantane (by heating with bromine in  $\text{CCl}_4$  solution under reflux) which serves as raw material for the preparation of the monotopic homologues of adamantane (Fig. 1). Using mostly the

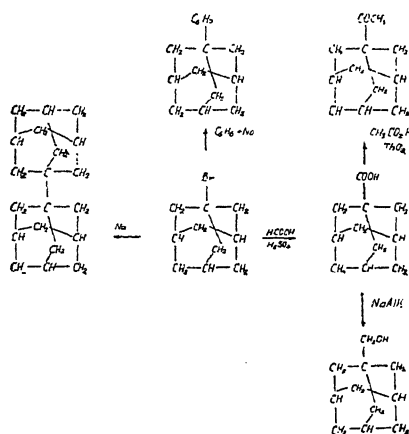


FIG. 1. Synthesis of Monotopic homologues of Adamantane.

Wurtz-Fittig procedure we prepared 5 monotopic homologues of adamantane and further 4 homologues by Grignard synthesis from adamantane carbon acid. 1-Ethyladamantane was prepared also by the reduction of methyladamantylketone. The monotopic homologues of adamantane are summarized in Table I. Preparation of the di- and tetratopic derivatives and homologues of adamantane is shown in Fig. 2.

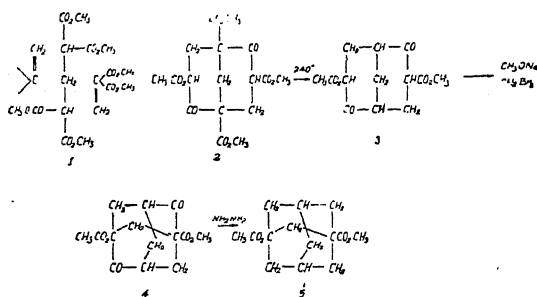


FIG. 2. Synthesis of ditopic homologues of Adamantane.

TABLE I  
Properties of homologues of adamantane

Hydrocarbon	Melting point	Boiling point	$n_D^{20}$
1-Methyladamantane	103	..	..
2-Methyladamantane	143-8-146	..	..
1-Ethyladamantane	-58	240	1.4955
1- <i>n</i> -Propyladamantane	-1	251	1.4962
1-Phenyladamantane	82	..	..
1-Cyclohexyladamantane	105	..	..
1, 1'-Diadamantyl	296	..	..
2-Adamantyl-1-propane	-20	105-107.8 mm.	1.4967
2-Adamantyl-1-butane	-44	119-12 1/8 mm.	1.5010
2-Adamantyl-1-pentane	under -50	233-240.8 mm.	1.4978
3-Adamantyl-1-pentane	-23	133-134	1.5000
1, 3-Dimethyladamantane	..	100-110/15 mm.	..
1, 3-Diisopropyladamantane	..	155-158/15 mm.	1.5190*
1, 3-Diisopropyladamantane	under -70	294-296	..
1, 3, 5, 7-Tetramethyladamantane	66-67	159/15 mm.	..
* $n_D^{17}$		..	..

We have replaced the original way of isolation of adamantane which consisted in thoroughly rectifying and freezing out the fractions containing adamantane by another, more effective method. Schiessler and Flitter found that hydrocarbons with a cross-section of  $5.8 \times 6.8 \text{ \AA}$ , which value represents the size of the channel in the thiocarbamide clathrate lattice, give crystalline clathrates with thiourea. On the model of adamantane we can see that according to its dimensions adamantane could give a clathrate with thiourea. This fact has been fully confirmed. A benzenic solution of adamantane mixed with a methanolic solution of thiourea immediately gave needle-like crystals of the clathrate. The clathrate is relatively stable, which is caused by the fact that the absolutely symmetric molecule of adamantane fits closely to the spaces of the lattice of the clathrate; this enables a mutual binding of covalent forces. Adamantane can be isolated even from those fractions of crude oil from which it does not separate any more when cooling to  $-70^\circ \text{C}$ . This means that formation of a clathrate with thiourea is a more effective way for the separation of adamantane from crude oil than the freezing out of a sharp fraction.

Not only adamantane, but also all its homologues prepared by us, e.g., diadamantyl, phenyladamantane, cyclohexyladamantane, ethyladamantane, propyladamantane and even dimethyladamantane form a clathrate with thiourea, which is caused by the fact that the substituents increase the dimension of the molecule in one direction only.

The clathrates were prepared by heating an 8% methanolic solution of thiourea with adamantane or with a mixture of its homologues in a sealed tube up to  $100^\circ \text{C}$ . On cooling, needle-like crystals of clathrate appeared, which—when cooled slowly—attained a length of several centimetres. 1, 1'-diadamantyladamantane and 1-cyclohexyladamantane yielded crystals of clathrate even from a warm solution, while the clathrate of phenyladamantane, ethyladamantane and propyladamantane needed some hours of standing at room temperature. This is caused by the fact that the substituents of 1-cyclohexyladamantane and diadamantyl contribute to form the clathrate. Phenyl-, ethyl- and propyl-groups are not clathrate-forming and if bound to a clathrate-forming molecule, they do not hinder the forming of the clathrate, but reduce its stability. This fact facilitates considerably the isolation of

adamantane and its homologues from crude oil. Thus it is possible to obtain a concentrate of hydrocarbons forming clathrates with thiourea which includes all monotopic homologues of adamantane and even some ditopic ones, as it results from preliminary experiments.

The great stability of the adamantane clathrate is the reason why from the mixture of hydrocarbons forming a clathrate with thiourea the adamantane passes with preference into this crystalline clathrate.

On this fact we based the method of the quantitative determination of adamantane in crude oils, which enables the determination of adamantane during 6 or 8 hours with a precision of 0.001%. In this way we have ascertained the presence of adamantane in further kinds of the Czechoslovakian crude oils.

It is worthy to mention that the clathrates of adamantane and its homologues represent the lowest ratio of weight of thiourea to hydrocarbons.

According to a paper by Rossini, in which he generalizes the results of the analysis of petrol from seven different crude oils, all crude oils contain substantially the same hydrocarbons and the main compounds in the petrol fraction of each crude oil can be divided into five groups, *i.e.*, *n*-paraffins, *i*-paraffins, alkylcyclopentanes, alkylcyclohexane and alkylbenzenes. In each of these five groups of hydrocarbons, individual compounds occur in ratios of equal rank for different crude oils. The different crude oils differ only by the different ratios of the groups of hydrocarbons, but in all crude oils each group contains the same hydrocarbons; also the mutual proportion of the different homologues remains the same.

The presence of adamantane was proved also in French crude oil of Le Lacque by Croxier, in U.S.A. crude oils by Mair and Rossini, and recently in U.S.S.R. crude oils. In Iraq crude oil thioadamantane was dis-

covered by Birch. It seems that the presence of adamantane and adamantane derivatives will not be limited only to some of these crude oils, but will occur in all naphthenic crude oils.

Although the formation of clathrates is a very effective method for the separation of adamantane and its homologues, many hydrocarbons forming clathrate with thiourea pass also into the precipitate so that the isolation is unsatisfactory. Therefore we have tried to separate the homologues of adamantane from other hydrocarbons forming clathrates with thiourea by means of chromatography. For this study 1-ethyladamantane has been chosen as a characteristic representative of this series. It had been prepared in a larger quantity by reduction of methyladamantylketone.

The chromatographic separation has been studied by S. Hala on binary mixtures with *n*-dodecane, decaline, dicyclohexylmethane and 1,2,4,5-tetramethylcyclohexane. On percolation we ascertained that some separation of ethyladamantane from the cyclic naphthenes occurred, but the separation was not sufficiently sharp. From this it can be deduced that crude oil fractions containing the lower homologues of adamantane could be enriched in this way by chromatography and at the same time the homologues of adamantane would follow behind the simple cycloparaffins and would accumulate among the dicycloparaffins and polyalkylcycloparaffins.

Thermodiffusion was found to be a much more effective method than chromatography for the separation of the homologues of adamantane from other naphthenes, eventually from *i*-paraffins.

From the crude oil of Hodonin about 10% were vaporized by means of steam. From this fraction we separated hydrocarbons forming clathrates with thiourea and consisting mostly of naphthenes, 74-88% of carbon atoms of the total number of carbon atoms



are present in naphthenic structures. The decomposed clathrates were freeze-dried, adamantane filtered off and the filtrate rectified. Six fractions boiling from 100°/15 mm. Hg up to 150°/15 mm. Hg were submitted to a repeated thermodiffusion in a batch equipment of current construction, consisting of two vertical concentric tubes 50 cm. high with a slit width of 0.4 mm. At the thermal gradient of 50° the equilibrium was reached in six hours. Five thermodiffusion fractions were collected and submitted to gas chromatographic analysis.

Until now only two of the five fractions, i.e., No. 1 and No. 3, have been analyzed by infra-red spectroscopy and both show seven distinct peaks. Peak No. 1 belongs to adamantane, peak No. 2 to 2-methyladamantane, peak No. 3 probably to 1-methyladamantane, No. 4 to 1-ethyladamantane, as could be proved by the injection of standards. Fraction No. 1 contains mostly adamantane and 2-methyladamantane, whilst fraction 3 mostly 1-ethyladamantane.

Mass spectra of these two fractions which were carried out by Messrs. Hanus and Dolejšek confirm the presence of the above-mentioned homologues of adamantane.

The mass spectra show that not only homologues of adamantane with 1 and 2 carbon atoms in side chains are present, but

also higher homologues with 3 and 4-carbon atoms are present. The investigated thermodiffusion fractions contain 20 to 80% of the homologue of adamantane.

Finally, a word may be said about the possible practical use of adamantane and its homologues. As it is known, the range of flight calculated according to Breguete formula

$$R = k.f. Q. \log \left( 1 + \frac{V}{P_0} \right)$$

depends first of all on the heating value and density of fuel, considering the fuel only. The heating value of a fuel is given by the hydrogen content according to the relation  $Q = 8650 + 122.2 H$ , where  $H$  is the percentage hydrogen. But the higher the hydrogen content the lower is the density.

This requirement which seems to be contradictory is fulfilled by naphthenes with several rings because they are fully saturated and the greater is the number of rings the higher is their density.

Adamantane and its homologues have nearly a heat calorific value of 10,000, and their density is approximately 1.00.

Supersonic fuels should be very heat stable, and the heat stability of some homologues of adamantane is extraordinary compared with other hydrocarbons.

## SEARCH FOR SUBMUONS

THE field of high-energy physics has seen the discovery of a large number of new particles and resonances, all with mass larger than the mass of the  $\pi$  meson. However, the mass region between the muon and the electron has not been extensively studied. In a paper communicated to the *Physical Review*, 15 August 1963, D. H. Coward and coworkers report the results of an experiment designed to search systematically for singly charged particles (*submuons*) with rest masses between that of the electron and muon, produced by electromagnetic pair production.

The incident photon beam was obtained by bombarding a one-inch thick block of carbon

with an 80 MeV electron beam from the Stanford Linear Electron Accelerator. The momentum of the secondary particles was determined by using a double-focusing, zero-dispersion magnetic spectrometer.

The results of this experiment which had high sensitivity rule out any but very short-lived singly charged particles in the mass range 5–175  $m_e$ . This result when combined with theoretical electrodynamics results on the vacuum polarisation leads to the conclusion that it is very unlikely that charged particles with rest mass between that of the electron and muon exist.—(*Phys. Rev.*, 1963, 131, 1782.)

## ON THE INTRACELLULAR LOCALIZATION AND BIOSYNTHESIS OF CATALASE IN LIVER TISSUE

T. M. RADHAKRISHNAN AND P. S. SARMA

Department of Biochemistry, Indian Institute of Science, Bangalore-12

**G**REAT deal of doubt exists in the literature regarding the intracellular distribution of catalase in the liver tissue. Euler and Heller<sup>1</sup> found only 16-23% of the total enzyme in the mitochondrial fraction. Ludewig and Chanutin,<sup>2</sup> however, observed about 45% in the mitochondria and Greenfield and Price<sup>3</sup> reported that 63% of the catalase could be recovered in the mitochondrial fraction provided that Polyvinyl Pyrrolidone was added to prevent the elution of the enzyme into the cell sap. Thomson and Klipfel<sup>4</sup> observed that catalase and uricase sediment closely together during gradient density centrifuging, in a particulate fraction lighter than the particles containing the succinic dehydrogenase and cytochrome oxidase. de Duve *et al.*<sup>5</sup> have observed a close relationship in the sedimentation properties of the particles containing uricase, catalase and D-amino-acid-oxidase and suggested that these enzymes are present in the subcellular particles distinct from both mitochondria and lysosomes.

The claims of the earlier investigators on the intracellular distribution of catalase using the Perfused rat liver tissue have been re-examined. 0.25, 0.33 and 0.88 M sucrose solutions were used as the homogenizing media and the technique of Schneider *et al.*<sup>6</sup> was adopted. In all cases it was found that about 60% of the catalase activity was present in the 100,000 × g. supernatant fraction. We could demonstrate the elution of catalase from the mitochondrial fraction when only 0.25 M sucrose solution was used for washing the mitochondria. Such an elution of catalase activity from mitochondria was considerably prevented when 0.88 M sucrose solution was used. Hence 0.88 M sucrose solution was selected for the study on the distribution of catalase in the liver tissues of mouse, rat, guinea-pig, rabbit, sheep and monkey. The catalase activities in the fractions were estimated by the titrimetric method of Euler *et al.*<sup>7</sup> as described by Radhakrishnan *et al.*<sup>8</sup> The protein content of the fractions was determined by the method of Lowry *et al.*<sup>9</sup> The results presented in Table I reveal that in all the species tested, the catalase activity is present mainly in 100,000 × g. supernatant fraction.

In view of the reports<sup>10-11</sup> on the alterations of catalase activity in the livers of hyper and

hypothyroid rats, experiments were undertaken to examine, in which subcellular fraction of the rat liver tissue, the catalase activity is affected under such a dietary condition. Young male albino rats weighing about 80-90 gm. were divided into three groups of six and the first group served as the control group (A) being maintained on a synthetic diet as described by Rajalakshmi *et al.*<sup>12</sup> The fat-soluble vitamins were supplied by mixing 2 to 3 drops of Adexolin (Glaxo Laboratories, Bombay, containing 12,000 I.U. of Vitamin A and 2,000 I.U. of Vitamin D<sub>2</sub> B.P. per gramme) in the diet twice in a week. In addition to the stock diet as supplied to the rats belonging to the first group (A) the second group of rats (B) were given each intraperitoneal injections of 0.5 mg. of 1-thyroxine on alternate days. The diet given daily to the third group of rats (C) was essentially the same as that of control rats excepting that it contained 50 mg. of 2-thiouracil in addition. All the rats were given food *ad lib*. The weights of the rats were recorded at the end of every week and the average growth rates of rats belonging to the three groups are given in Fig. 1. At the end of the

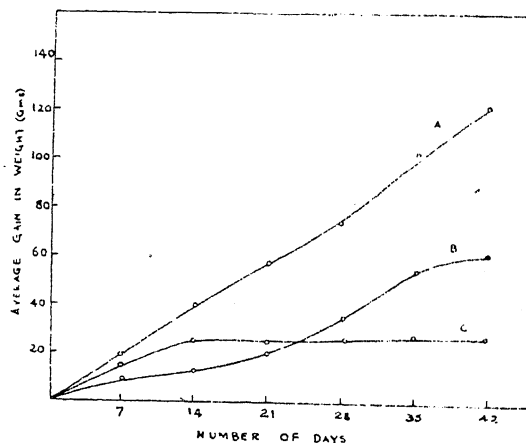


FIG. 1. Growth rate of control, hyper and hypothyroid rats. A, B and C represent the growth curves of control, hyper and hypothyroid rats respectively.

sixth week, the animals were killed and the catalase activity in the blood and in the subcellular fractions of the liver tissues was estimated. The results summarized in Table II show that the catalase activity in the super-

TABLE I  
Intracellular distribution of catalase in liver tissues of various animals

Fraction	Mouse			Rat			Guinea-pig		
	Protein mg.	% Protein	% Catalase activity	Protein mg.	% Protein	% Catalase activity	Protein mg.	% Protein	% Catalase activity
Whole Homogenate	126.0	100.0	100.0	137.0	100.0	100.0	144.0	100.0	100.0
Nuclei	15.3	12.1	5.0	18.0	13.0	10.0	15.0	10.4	1.0
Mitochondria	21.2	16.8	35.0	34.0	25.0	23.0	20.2	14.0	9.0
Microsomes	18.5	14.7	10.0	21.0	16.0	8.0	16.9	11.7	3.0
Supernatant	50.7	40.2	47.0	60.0	44.0	58.0	66.0	45.8	83.0
TOTAL	105.7	83.8	97.0	133.0	98.0	99.0	118.1	81.9	96.0

Fraction	Rabbit			Sheep			Monkey		
	Protein mg.	% Protein	% Catalase activity	Protein mg.	% Protein	% Catalase activity	Protein mg.	% Protein	% Catalase activity
Whole Homogenate	125.0	100.0	100.0	92.5	100.0	100.0	168.0	100.0	100.0
Nuclei	18.0	14.0	8.0	11.9	12.8	6.0	23.4	13.9	8.0
Mitochondria	29.0	23.0	15.0	13.2	14.3	11.0	24.2	14.4	17.0
Microsomes	20.0	16.0	7.0	13.7	14.8	3.0	30.9	18.3	9.0
Supernatant	53.0	44.0	68.0	55.0	59.5	77.0	82.8	49.2	66.0
TOTAL	120.0	97.0	98.0	93.8	101.4	97.0	161.3	95.8	100.0

The catalase activity was calculated in terms of n.l. of 0.1 N potassium permanganate equivalent to hydrogen peroxide consumed per minute per mg. protein. The relative activities are expressed as percentage activities of the whole homogenates.

TABLE II  
Influence of hyper and hypothyroidism on the catalase activities in the subcellular fractions of rat liver tissue and in blood

Fraction	% Change in catalase activity*	
	Hypothyroid rats	Hypothyroid rats
Liver† .. Whole homogenate	-25.0	-42.0
Supernatant	-29.0	-37.0
Blood .. Erythrocytes	+20.0	+16.0

\* The catalase activities calculated as mentioned under Table I are expressed as % change over the control rats. The figures represent the average of six values.

† The nuclear, mitochondrial and the microsomal fractions of the liver tissues showed no change in the catalase activity.

natant fraction alone was affected under these dietary conditions. However the blood catalase activity was found to have increased slightly in both hypo and hyperthyroid animals.

In view of the above observations on the intracellular localization of liver catalase, the

incorporation of  $Fe^{59}$  into catalase has been studied. The preliminary results obtained in the *in vivo* and *in vitro* experiments with rats revealed that only the catalase isolated from the supernatant fraction of the liver tissue contained the maximum  $Fe^{59}$  activity. When the subcellular distribution of  $Fe^{59}$  in 'Heme' was measured it was found that only the mitochondrial fraction exhibited the maximum radioactivity. Further, in view of the presence of Heme' synthetase<sup>13,14</sup> in mitochondria, it is possible that mitochondria has a role in the biosynthesis of the prosthetic group of catalase. The results obtained in support of this concept will form the subject-matter of a detailed communication to be published elsewhere.

Our thanks are due to Rockefeller Foundation, New York, for financial support. We are also thankful to Dr. D. S. R. Sarma for his keen interest and kind help in the progress of the work. One of us (T. M. R.) is thankful to the University Grants Commission, New Delhi, for the award of a Junior Research Fellowship.

1. Euler, H. V. and Heller, L., *Z. Krebsforsch.*, 1949, **56**, 393.
2. Ludewig, S. and Chanutin, A., *Arch. Biochem.*, 1950, **29**, 441.
3. Greenfield, R. E. and Price, V. E., *J. Biol. Chem.*, 1956, **220**, 607.
4. Thomson, J. F. and Klipfel, F. J., *Arch. Biochem. Biophys.*, 1957, **70**, 224.
5. de Duve, C., Beaufay, H., Jacques, P., Rahman, Li, Y. and Sellinger, O. Z., *Biochem. Biophys. Acta*, 1960, **40**, 186.
6. Schneider, W. C. and Hogeboom, G. H., *J. Biol. Chem.*, 1950, **183**, 123.
7. Euler, H. V. and Josephson, K., *Leibigs. Ann.*, 1927, **455**, 1.
8. Radhakrishnan, T. M., Raghupathy, E. and Sarma, P. S., *Indian J. Chem.*, 1963, **1**, 40.
9. Lowry, O. H., Rosebrough, N. J., Farr, A. L. and Randall, R. J., *J. Biol. Chem.*, 1951, **193**, 265.
10. Saxena, Y. R., Viswanathan, P. N., Mehrotra, R. M. L. and Krishnan, P. S., *Enzymologia*, 1961, **23**, 57.
11. Ramachandran, L. K. and Sarma, P. S., *Jour. Sci. and Ind. Res.*, 1954, **13B**, 115.
12. Rajalakshmi, S., Sarma, D. S. R. and Sarma, P. S., *Biochem. J.*, 1961, **80**, 375.
13. Nishida, G. and Labbe, R. F., *Biochem. Biophys. Acta*, 1959, **31**, 519.
14. Mina Kami, S., Yoneyama, Y. and Yoshikawa, H., *Ibid.*, 1958, **28**, 447.

## INTERNATIONAL SYMPOSIUM ON CONTINUUM MECHANICS

THE importance of Continuum Mechanics to bridge the gulf between microscopic and macroscopic description of natural phenomena is now widely recognised. It has received attention from a large number of prominent workers all over the world. The International Union of Theoretical and Applied Mechanics (IUTAM) could not have done better than to hold a Symposium on this subject at Tbilisi, Georgia, U.S.S.R., from September 17th to 23rd, 1963.

The analytical theory of functions plays a vital role in the mathematical description of continuum problems. It was, therefore, in the fitness of things that the symposium was held under the Chairmanship of Professor N. I. Muskhelishvili, President of the Georgian Academy of Sciences, who along with his co-workers has contributed a lot to the applications of the Theory of Functions of Complex Variables to problems in mechanics.

Participation in the conference was by invitation and 61 foreign workers and 55 Russian workers attended it. 20 countries were represented and 70 research papers were presented, which included six general lectures.

The general lectures reviewed the work of various schools. N. I. Muskhelishvili dealt with Elasticity and L. I. Sedov with Hydrodynamics. I. N. Sneddon, F. G. Tricomi, S. Bergman, L. A. Galin gave applications of Integral Equations. Non-linear problems were treated by B. R. Seth, Z. N. Dobrovol'skaya, A. A. Dorodnitsyn and J. P. Germain. A number of papers dealt with contact problems.

The spectral analysis of continuum phenomena can be split into two parts—linear and non-linear. The middle part of the spectrum is generally linear and has been extensively dealt with. But the transition from the linear to non-linear at the ends of the spectrum has not received sufficient attention. This involves

the determination of asymptotic solutions at the turning points of differential systems. The theory of analytic functions of one or more complex variables whose use was extensively illustrated at the conference can be further extended to asymptotic solutions. Another modern trend to which attention should be drawn is the reduction of solutions of problems to integral equations, which can be readily solved on high speed digital computers. In fact, one such problem, arising out of the formations of small waves on a non-uniform bed, was suggested by the digital computer. It is unfortunate that in India, we are still not very conscious of the importance of high speed computers as a powerful tool to solve scientific problems. It is hoped that the start made in such computation at Bangalore, Kharagpur, Kanpur and Bombay will spread to many other centres in the country. The problem of asymmetrical stress distribution due to internal stress couples was discussed in two papers. Such situations arise on the microscopic level, and hence the treatment of such problems brings the two fields closer together. Thin and shallow shell problems were treated by a number of Russian workers. Magneto-hydrodynamical problems attracted few participants. In such cases a disturbing effect is observed about the vanishing and reversal of lift, if the external magnetic field reaches certain critical strength in relation to the flow velocity. Attention was also drawn to problems in which the main difficulty lies in the fact that the regions in which the solution is sought is unknown. It was also shown that a number of problems like flow past cascades of profiles and the bending of plates weakened by an infinite set of periodical holes can be reduced to problems for automorphic functions.

Indian Institute of Technology, B. R. SETH.  
Kharagpur.

# EMBRYOLOGY AND SYSTEMATIC POSITION OF *CROSSOSOMA CALIFORNICUM* NUTT.

R. N. KAPIL AND R. S. VANI

Department of Botany, University of Delhi, Delhi-6

**D**IVERSE opinions have been expressed regarding the systematic position of the genus *Crossosoma*. Benthams and Hooker<sup>1</sup> included it in the Dilleniaceae; Engler and Prantl<sup>3</sup> raised this taxon to the rank of a family, the Crossosomataceae, and placed it near the Rosaceae in the Geraniales and Hutchinson<sup>4</sup> and Eames<sup>2</sup> in the Dilleniales. Lawrence<sup>5</sup> has included the Crossosomataceae in the Rosales. Lemesle<sup>6,7</sup> studied the wood anatomy of *Crossosoma californicum* and assigned the family to the Ranales between the Paeoniaceae and the Ranunculaceae. He derived it from the Paeoniaceae. In view of the above controversy, and lack of embryological data on this family, the present investigation was undertaken. The material of *Crossosoma californicum* was obtained from Dr. Sherwin Carlquist of Claremont, California, U.S.A., through the courtesy of Professor P. Maheshwari.

The flowers are solitary and terminal, and are borne on short shoots. They are bisexual and regular with a long pedicel (Figs. 1, 2). The calyx consists of five, connate, persistent sepals forming a turbinate tube. There are five free orbicular petals. The stamens are numerous, free and inserted on the rim of the hypanthium. The gynoecium is tricarpeal (rarely tetracarpeal) and apocarpous, although sometimes two of the carpels are fused (Figs. 3-5). The ovary bears a number of ovules which are arranged in two rows on a marginal placenta. Small rosettes of acicular crystals are present in all the floral parts.

In a young anther, the sporogenous cells are surrounded by a glandular tapetum, three middle layers, an endothecium, and an epidermis (Fig. 6). Initially the tapetum is single-layered and the cells are uninucleate. However, it becomes irregularly 2- or 3-layered and the nuclei become polyploid due to repeated divisions and fusions (Figs. 7-10). The pollen grains are tricolporate (Fig. 11) and are shed at the 2-celled stage.

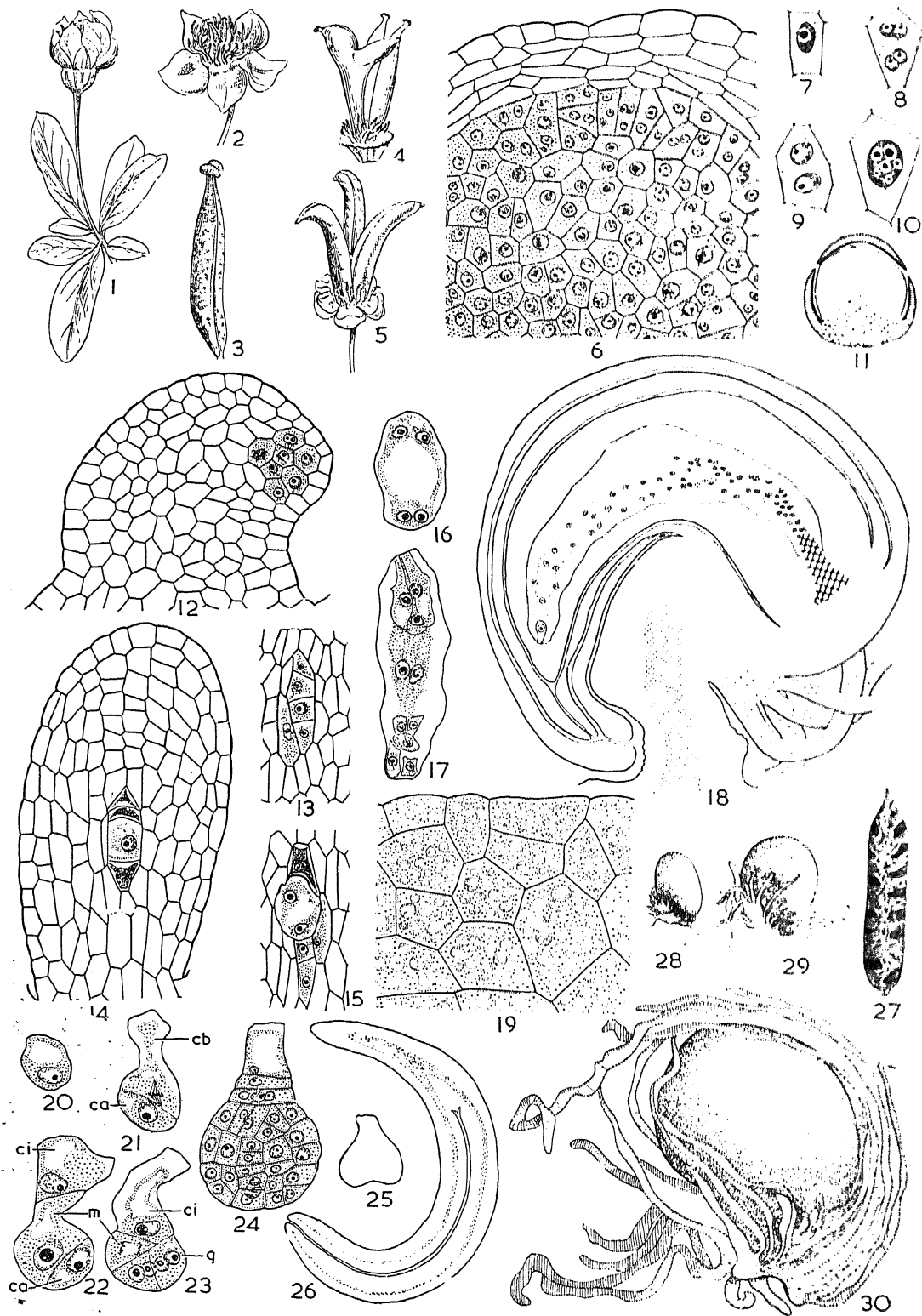
The ovules are campylotropous, bitegmal and crassinucellar. A multicelled hypodermal archesporium differentiates in the young nucellus (Fig. 12). The subepidermal cells of the archesporium cut off the primary parietal cells which by further divisions produce a massive 6- or 7-layered parietal tissue (Fig. 14).

Only one mother cell divides to give rise to a linear tetrad of megaspores. However, a few cells of the nucellus adjacent to it contain dense cytoplasm and prominent nuclei (Figs. 13-15). They may possibly be interpreted as unreduced embryo sac initials but we have not found them to develop any further. Often the second megaspore from the chalazal end functions (Fig. 14), but any of the other three megaspores may engender an embryo sac. Subsequent mitoses of the functioning megaspore result in 2-, 4- and 8-nucleate embryo sacs (Figs. 15-17). The development, thus, conforms to the Polygonum type. The synergids start degenerating soon after fertilization but occasionally one of them may persist for some time. The polar nuclei fuse before fertilization. There are three antipodal cells which frequently divide to form five or six cells (Fig. 17).

Fertilization is porogamous and the endosperm is Nuclear (Fig. 18). Centripetal wall formation sets in at the micropylar end at the globular stage of the proembryo and the endosperm becomes completely cellular by the time the embryo is heart-shaped and contains fatty food reserves (Fig. 19).

The zygote (Fig. 20) divides only after a large number of endosperm nuclei are formed. The first division is transverse resulting in a small apical cell *ca* and a large basal cell *cb* (Fig. 21). The cell *cb* divides earlier than *ca* by an obliquely transverse wall, forming the tiers *m* and *ci* (Fig. 22). The cell *ci* remains undivided while *m* undergoes a transverse division to form the cells *d* and *f*. The apical cell divides vertically and then transversely to give rise to the quadrant and the octant stages. Further divisions proceed in all planes resulting in a globular and later a heart-shaped proembryo (Figs. 23-25). The mature embryo is large, dicotyledonous and curved, and occupies a major portion of the seed (Fig. 26).

The fruit is a follicle and contains several fertile seeds which are reniform and black. The seed coat consists of 4 or 5 layers of highly sclerified cells of the outer integument and a single fibrous layer contributed by the inner epidermis of the inner integument. A well developed fimbriate aril partially envelops the seeds (Fig. 27). It differentiates as a small



FIGS. 1-30. Fig. 1. Twig bearing a flower,  $\times 1$ . Fig. 2. Open flower showing free stamens,  $\times 1.5$ . Fig. 3. Carpel,  $\times 3$ . Fig. 4. Abnormal pistil with two free and two fused carpels,  $\times 1.5$ . Fig. 5. Mature fruits,  $\times 1$ . Fig. 6. T.s. portion of anther at the microspore mother cell stage showing epidermis, endothecium, three middle layers and an irregularly 2- or 3-layer red tapetum,  $\times 453$ . Figs. 7-10. Nuclear divisions and fusions in tapetal cells,  $\times 741$ . Fig. 11. Palynogram,  $\times 453$ . Fig. 12. L.s. young nucellus with multicelled archesporium,  $\times 412$ . Fig. 13. Linear tetrad of megaspores; a possible unreduced embryo sac initial is also seen,  $\times 412$ . Fig. 14. Functioning megaspore,  $\times 412$ . Figs. 15-17. 2-, 4-, and 8-nucleate embryo sacs,  $\times 412$ . Fig. 18. L.s. young seed showing zygote and free nuclear endosperm,  $\times 67$ . Fig. 19. Cells of mature endosperm packed with fatty food reserves,  $\times 453$ . Figs. 20-25. Stages in development of embryo, Figs. 20-24,  $\times 412$ ; Fig. 25,  $\times 67$ . Fig. 26. Mature embryo,  $\times 25$ . Fig. 27. Fruit with pericarp removed; note seeds partly covered by aril,  $\times 1.5$ . Figs. 28-29. Young ovules showing initiation and branching of aril,  $\times 58$ . Fig. 30. Mature seed enveloped by fimbriate aril,  $\times 29$ .

annular structure at the base of the funiculus (Fig. 28). As it grows it becomes lacinate and surrounds the seed on the sides (Figs. 29, 30). It is devoid of any vascular supply. Its cells have scanty cytoplasm and remain uninucleate throughout.

*Crossosoma* resembles the peonies in having perigynous, bracteate, and bisexual flowers; numerous stamens; an apocarpous gynoecium; multicelled archesporium; and a Polygonum type of embryo sac. However, it stands apart from them in possessing simple leaves; vessels with simple perforations; rosettes of small acicular crystals in all the floral and vegetative parts; a whorled perianth; free and cyclic stamens; campylotropous ovules; a non-vascularized aril; single embryo sac; and a large, curved embryo. A more significant difference lies in the presence of a coenocytic phase in the procmbryo of *Paconia* which is conspicuously absent in *Crossosoma*. Hence any close relationship between *Crossosoma* and *Paconia* is unwarranted.

Morphologically and embryologically the Ranunculaceae differ from *Crossosoma* in the presence of hypogynous flowers, centripetal development of the stamens, a single-layered tapetum, anatropous ovules, a parietal tissue partly formed by the periclinal divisions of the nucellar epidermis, occurrence of both Allium and Polygonum types of embryo sacs, persistent and polyploid antipodal cells, a minute and straight embryo, and non-arillate seeds. Thus a position intermediate between the Ranunculaceae and Paoniaceae is not justified for *Crossosoma*.

No doubt there are striking similarities in the flowers of *Crossosoma* and the Rosaceae like perigyny, numerous free stamens, and apocarpous gynoecium but this family has several characteristic features which have no parallel in the Crossosomataceae. For example, in the Rosaceae the leaves are usually compound, the vessels are in small groups, crystals are either solitary or clustered, the stamens are centripetal, the pollen grains are united in loose tetrads, the ovules are anatropous (sometimes uni-

tegminal), the seeds are non-arillate with a small and straight embryo with hardly any endosperm, and apomixis is common. Therefore, the assignment of the Crossosomataceae to the Rosales near the Rosaceae must also be rejected.

*Crossosoma* differs from the Dilleniaceae in having free, perigynous stamens (Hutchinson<sup>4</sup>); tapetal cells with polyploid nuclei; a multicelled female archesporium; a large, curved embryo; and rosettes of small acicular crystals. The absence of tubes or sacs filled with raphides and crystal sand also indicates that the genus has no affinities with the Dilleniaceae (Metcalfe and Chalk<sup>8</sup>). However, the two families show several common features: (1) simple leaves; (2) isolated vessels; (3) secretory tapetum; (4) tricolporate pollen grains; (5) campylotropous, bitegminal, crassinucellar ovules; (6) Polygonum type of embryo sac; (7) Nuclear endosperm; and (8) reniform and arillate seeds.

It is concluded that although *Crossosoma* appears to be more appropriately allied to the Dilleniaceae than to the other families mentioned earlier, it is necessary to investigate more genera of the Dilleniaceae before a final word can be said about its relationships.

It is a pleasure to thank Professor P. Maheshwari for his generous counsel and Dr. N. N. Bhandari for suggestions. Acknowledgements are expressed to the Government of India for the award of a Junior Research Fellowship to one of us (R. S. V.).

1. Bentham, G. and Hooker, J. D., *Genera Plantarum*, London, 1862.
2. Eames, A. J., *Morphology of the Angiosperms*, New York, 1961.
3. Engler, A. and Prantl, K., *Die natürlichen Pflanzenfamilien*, Leipzig, 1889.
4. Hutchinson, J., *The Families of Flowering Plants*, 2, Oxford, 1959.
5. Lawrence, G. H. M., *Taxonomy of Vascular Plants*, New York, 1951.
6. Lemesle, R., *C.R. Acad. Sci.*, Paris, 1948, 227, 221.
7. —, *Phytomorphology*, 1955, 5, 11.
8. Metcalfe, C. R. and Chalk, L., *Anatomy of the Dicotyledons*, 1, Oxford, 1950.

## LETTERS TO THE EDITOR

ENERGY OF THE SCHWARZSCHILD  
EXTERIOR FIELD\*

Using Møller's superpotential<sup>1</sup>

$$\chi_i^{kl} = -\chi_i^{lk} \\ = \frac{\sqrt{-g}}{8\pi} (g_{in,m} - g_{im,n}) g^{km} g^{ln}, \quad (1)$$

Florides<sup>2</sup> found that the  $\Psi_4^4$  component of the energy momentum complex

$$\Psi_i^k = \chi_i^{kl}, \quad (2)$$

comes out to be zero for Schwarzschild exterior field, thus giving zero energy outside the Schwarzschild singularity. He therefore concluded that all the gravitational energy resides wholly inside the material system associated with the field, i.e., the gravitational field surrounding the material system is devoid of any gravitational energy.

Møller himself has later on discovered<sup>3</sup> that the complex  $\Psi_i^k$  does not have all the properties required for a satisfactory description of the energy distribution. He has then developed a satisfactory solution of the same problem in the framework of a tetrad formalism of the general relativity theory.<sup>4</sup> In the same paper Møller has shown that for the static metric

$$-ds^2 = a(r) [(dx^1)^2 + (dx^2)^2 + (dx^3)^2] - b(r) dt^2, \quad (3)$$

the correct choice of tetrads is available which leads to the tetrad superpotential  $U_i^{kl}$  that is identical with the Einstein superpotential  $h_i^{kl}$  and given by\*\*

$$U_i^{kl} = h_i^{kl} \\ = \frac{\sqrt{ab}}{8\pi} \frac{d}{dr} \left[ \log \frac{a/b}{\sqrt{|g_{ii}|}} \right] (\delta_i^k \eta^l - \delta_i^l \eta^k) \quad (4)$$

where

$$\eta^k = \left\{ \frac{x^1}{r}, \frac{x^2}{r}, \frac{x^3}{r}, 0 \right\}. \quad (5)$$

We now apply this formula to the Schwarzschild exterior field in spherically

symmetric isotropic co-ordinates with the substitution,

$$a(r) = \left(1 + \frac{m}{2r}\right)^4, \quad b(r) = \frac{\left(1 - \frac{m}{2r}\right)^2}{\left(1 + \frac{m}{2r}\right)^2}. \quad (6)$$

(4) gives the following non-zero components of  $U_i^{kl}$ , viz.,

$$U_4^{4a} = - \left(1 - \frac{m}{2r}\right) \frac{m x^a}{4\pi r^3}, \quad a = 1, 2, 3.$$

Then the energy momentum complex component  $\tau_4^4$  given by

$$\tau_4^4 = U_4^{4l}, \quad (7)$$

becomes

$$\tau_4^4 = - \frac{m^2}{8\pi r^4}.$$

Thus we get a non-zero energy density in the field outside the material system as compared to the zero value for the same in Florides' application of Møller's superpotential (1).

The total energy  $H_{\text{ext}}$  outside the material system is given by

$$H_{\text{ext}} = - \iiint \tau_4^4 dx^1 dx^2 dx^3. \quad (8)$$

If  $r = r_1$  is the radius of the singularity the total energy outside the singularity will be, after changing to spherical polar co-ordinates,

$$H_{\text{ext}} = \int_0^{2\pi} \int_0^\pi \int_{r_1}^\infty \frac{m^2}{8\pi r^4} r^2 \sin \theta dr d\theta d\phi, \\ = \frac{m^2}{2r_1}.$$

We conclude therefore that the gravitational field outside the material system does possess gravitational energy.

I would wish to put on record my thanks to Prof. J. Weber and Prof. D. Zepoy of the University of Maryland for helpful discussions.

Physical Research Laboratory, K. B. SHAH.  
Ahmedabad-9, October 14, 1963.

\* Part of the thesis presented by the author for M.S. Degree at the University of Maryland, U.S.A.

\*\* Here we have corrected the misprint in Møller's paper cited in reference 4.

1. Møller, C., *Annals of Physics*, 1958, **4**, 347.
2. Florides, P. S., *Proc. Camb. Phil. Soc.*, 1962, **58**, Part 1, 102.
3. Møller, C., *Annals of Physics*, 1961, **12**, 118.
4. —, *Mat. Fys. Skr. Dan. Vid. Selsk.*, 1961, **1** (10).



ON AN EMPIRICAL REGULARITY IN  
THE ENERGY SPECTRA OF SOME  
ODD-MASS NUCLEI

A REGULARITY in the level spacing of some odd- $A$  nuclei with 31, 33 and 37 neutrons has been pointed out by Wapstra.<sup>1</sup> It is the purpose of this short note to bring attention to a similar regularity in the spectra of some odd-mass nuclei with 51, 53 and 55 protons. In these nuclei the level spacing is found to obey the energy sequence given by

$$E = n^2 E_0$$

where  $n$  is an integer and  $E_0$  some basic energy value.

Table I shows this regularity rather well. The nuclei that show this regularity are Sb-121, I-127, I-131, Cs-131 and Cs-133.

TABLE I

$n$	Sb <sup>121</sup>		I <sup>127</sup>		I <sup>131</sup>		Cs <sup>131</sup>		Cs <sup>133</sup>	
	$E^{51}$ (Kev)	$E_0$	$E^{53}$ (Kev)	$E_0$	$E^{55}$ (Kev)	$E_0$	$E^{55}$ (Kev)	$E_0$	$E^{55}$ (Kev)	$E_0$
1	..	..	..	..	..	..	..	..	..	..
2	70	18	57	14	147	37	124	31	81	20
3	..	..	..	..	..	..	216	24	160	18
4	..	..	203	13	600	38	372	23	380	24
5	..	..	370	15	..	..	620	25	440	18
6	576	16	418	12	..	..	1030	28	..	..

On account of the known spins of these levels, rotational description is ruled out. But the form of the regularity suggests, nevertheless, some form of collective effect in these nuclei. It would be interesting to find an explanation theoretically for this regularity.

Dept. of Physics, S. M. BRAHMAVAR.  
Karnatak University, M. K. RAMASWAMY.  
Dharwar-3, April 22, 1963.

1. Nussbaum, Wapstra, Pruil, Sterk, Nijgh and Grobden, *Phys. Rev.*, 1956, **101**, 905.

DIAMAGNETIC ANISOTROPY OF  
PYRIDINE AND THE SUSCEPTI-  
BILITIES OF DIHYDRO- AND  
TETRAHYDRO-PYRIDINES

UNDER suitable conditions, pyridine can be reduced to give dihydro-, tetrahydro- and hexahydro-pyridine (piperidine), in different stages of hydrogenation. In each stage a double bond in the ring is converted into a single bond followed by addition of two hydrogen atoms to the molecule. In this respect these four heterocyclic compounds form a sequence, similar to the one formed by benzene, cyclohexadiene,

cyclohexene and cyclohexane. The magnetic susceptibilities of pyridine and piperidine have been experimentally determined. However, there are no experimental data on the two intermediate compounds, probably because they are not very stable. An attempt is made here to evaluate their diamagnetic susceptibilities from the known values of those of the end members of the sequence.

Pyridine resembles closely with benzene in its general behaviour. Both the molecules have plane, six-membered cyclic structures. Both are aromatic compounds, a property arising from the cyclic conjugation of the double bonds in their rings and the consequent delocalisation of the six  $\pi$ -electrons. The energy of resonance of pyridine structure is almost the same as that of benzene.<sup>1</sup> Benzene molecule is a regular

hexagon with all the C—C distances<sup>2</sup> equal to 1.39 Å, while pyridine molecule is a slightly distorted hexagon with the C—C distances equal to 1.40 Å and C—N distances<sup>2</sup> equal to 1.36 Å. It is known that benzene molecule is magnetically anisotropic and has a larger diamagnetic susceptibility perpendicular to the plane of the molecule than in any direction in its plane. It is also known that this property is mainly due to the magnetically induced motion of the six  $\pi$ -electrons around the entire ring.<sup>3</sup> Considering the similarity of the structures of pyridine and benzene, it can be said that pyridine molecule should also be magnetically anisotropic with a larger diamagnetic susceptibility perpendicular to the plane of the ring than in any direction in its plane. Assuming that the six  $\pi$ -electrons of the pyridine molecule move around the ring under the influence of a magnetic field, taking the weighted mean (1.385 Å) of the six sides of the molecule as the radius of this ring current and using Langevin's formula, the diamagnetic susceptibility perpendicular to the plane of the molecule, arising only from the six  $\pi$ -electrons, can be calculated. The value for a gram-molecule comes out to be  $-48.9$ . (All susceptibility values

in this paper are expressed in c.g.s.e.m. units  $\times 10^{-6}$ .) Following the arguments given by the authors<sup>4</sup> in case of benzene, it follows that the contribution of this enhanced diamagnetism, perpendicular to the plane of the ring, to the measured susceptibility of liquid pyridine will be  $1/3$  of this value, i.e.,  $-16.3$ . This is in fair agreement with the value given by Ingold<sup>5</sup> for what he calls the conjugative exaltation. The experimental gram-molecular susceptibility of liquid pyridine<sup>6</sup> is  $-49.4$ . Hence the isotropic part of its susceptibility comes out as  $-33.1$ . Here the anisotropy due to the six  $\sigma$ -bonds and the possible anisotropy in the plane of the ring produced by the heterocyclic nature of the molecule are neglected.

Dihydropyridine is produced in the first stage of the hydrogenation of pyridine. There are five isomeric forms of this compound,<sup>7</sup> namely 1:2-, 1:4-, 2:3-, 2:5-, and 3:4-. However, for the present purpose these may be divided into two groups, depending on which one of the three double bonds is broken during reduction. In the first two isomers (hereafter called group A isomers) the  $C=N$  is broken during the reduction, whereas in the others (known as group B) one of the two  $C=C$  is absent. If the conversion of a  $C=C$  into a  $C-C$  and the addition of two hydrogen atoms to the molecule is assumed to produce the same increase in the diamagnetic susceptibility as in the reduction of benzene to cyclohexadiene,<sup>4</sup> i.e.,  $9.76$  then the susceptibility of the group B isomers of dihydropyridine is obtained by adding this increment to the isotropic part of the susceptibility of pyridine, evaluated above. This value comes out as  $-42.86$ . The susceptibility of the group A isomers is likely to be different from this because these isomers are obtained by breaking the  $C=N$  bond. An estimate of their susceptibility will be made later.

Tetrahydropyridine is produced in the second stage of the reduction of pyridine. There are three isomers of this compound.<sup>8</sup> These are 1:2:3:4-, 1:2:3:6-, 2:3:4:5-. Again, for the present purpose these may be divided into two groups. The first two (group C) are obtained by the conversion of  $C=N$  into  $C-N$  during reduction and the last one (group D) has its  $C=C$  changed into a  $C-C$ . Following the arguments given above one can conclude that the susceptibility of the group D isomer of tetrahydropyridine will be  $-52.62$ . As the formation of the group C isomers involves a  $C=N$  bond, their susceptibility is likely to

be different from this and will be estimated in the next paragraph.

In the last stage of reduction all forms of tetrahydropyridine are converted into piperidine. To obtain this compound from the group D isomers, one has to change a  $C=N$  into  $C-N$  and add two hydrogen atoms to the molecule. As the experimental gram-molecular susceptibility of piperidine<sup>6</sup> is  $-64.3$  and the estimated susceptibility of group D isomer is  $-52.62$ , it may be said that this conversion increases the diamagnetic susceptibility by  $11.68$  units. Using this value it is now possible to estimate the susceptibility of the group A and group C compounds. These values come out as  $-44.78$  and  $-54.54$  units respectively.

Table I gives in summary, the principal molecular susceptibilities of pyridine and the estimated diamagnetic susceptibilities of the different forms of dihydro- and tetrahydropyridines.

TABLE I

*Principal molecular susceptibilities of pyridine and the diamagnetic susceptibilities of di- and tetrahydropyridines*

Pyridine	Dihydropyridine		Tetrahydropyridine	
	Group	$\chi$	Group	$\chi$
* $K_1 = K_2 = -33.1$	A	$-44.78$	C	$-54.54$
$K_3 = -82.0$	B	$-42.86$	D	$-52.62$

\*  $K_1$ ,  $K_2$  and  $K_3$  are the principal molecular susceptibilities,  $K_1$  and  $K_2$  being in the plane of the molecules and  $K_3$  in a direction perpendicular to this plane.

Physics Department, V. T. DESHPANDE,  
University College of Science, K. G. PATHKI,  
Osmania University,  
Hyderabad-7, June 17, 1963.

1. Packer, J. and Vaughan, J., *A Modern Approach to Organic Chemistry*, Clarendon Press, Oxford, 1958, p. 902.
2. Wells, A. F., *Structural Inorganic Chemistry*, Clarendon Press, Oxford, 1950 pp. 512 and 532.
3. Pauling, L., *Jour. Chem. Phys.*, 1936, **4**, 673.
4. Deshpande, V. T. and Pathki, K. G., *Curr. Sci.*, 1961, **30**, 377.
5. Ingold, C. K., *Structure and Mechanism in Organic Chemistry*, Cornell University Press, 1953, p. 192.
6. *J. C. T.*, 1929, **6**, 361.
7. Klingsberg, E., *Pyridine and Its Derivatives*, Interscience Publishers Inc., 1960, p. 77.
8. —, *Ibid.*, p. 83.

# A NOTE ON THE MAGNETIC SUSCEPTIBILITIES OF ROCKS IN THE WEST GODAVARI DISTRICT, ANDHRA PRADESH

The author conducted a vertical magnetic survey in the West Godavari District covering an area of about 1,300 square miles, falling between the latitudes  $16^{\circ} 45'$  and  $17^{\circ} 20'$  and the longitudes  $81^{\circ} 0'$  and  $81^{\circ} 30'$ . In order to interpret the vertical magnetic intensity anomaly contour map, the author has determined the susceptibilities of rock samples collected from this area. The rock formations in this area comprise (1) Archaean metamorphics which constitute the basement and which are mainly of Khondalitic nature, (2) Barakar sandstones, (3) Chintalapudi sandstones (Kamthis), (4) Gollapalli sandstones, (5) Raghavapuram shales, (6) Tirupati sandstones, (7) Deccan trap (basalt) and (8) Rajahmundry sandstones (Fortranes). Charnockite intrusives ranging from ultrabasic to acid varieties are also encountered in the Archaean hills. Barakans and the Chintalapudis are lower Gondwanas while Gollapallis, Raghavapuram shales are the upper Gondwanas. About 200 rock samples were studied and their susceptibilities determined using a bridge based on the principle of Mooney's apparatus.<sup>7</sup> Table I summarises the average susceptibility values for the different rock types.

TABLE I

Rock formation	Number of samples studied	Average susceptibility $\times 10^6$
Archaean metamorphics ..	25	178.00
Barakar sandstones ..	20	29.00
Chintalapudi sandstones ..	30	31.00
Gollapalli sandstones ..	19	49.00
Raghavapuram shales ..	15	20.05
Tirupati sandstones ..	29	51.00
Rajahmundry sandstones ..	19	68.00
Deccan trap ..	26	from 1895 to 2914
Charnockites ..	8	from 492 to 7491

As can be seen, the susceptibility contrast, in many cases, between the Archaean and the overlying sediments is not very great. This emphasises the need of a careful consideration of all concerned factors before one can decisively say whether the magnetic anomalies encountered in this area are attributable to the basement topography.

It is almost universally accepted that magnetite is mainly responsible for the magnetic behaviour of any rock as far as geophysical prospecting is concerned. The

author, therefore, studied the dependence of magnetite susceptibility of rocks on the magnetite content and arrived at the following empirical relation:

$$K_s = (0.08894 \pm 0.00287) Q_m^{10-3}$$

where  $K_s$  is the specific susceptibility and  $Q_m$  is the percentage of magnetite,  $\pm 0.00287$  being the magnitude of minimum deviation.

The author is indebted to Prof. M. S. Krishnan and Prof. B. Sundara Rama Rao for their encouragement and guidance and to the Council of Scientific and Industrial Research for the award of a Senior Research Fellowship.

Dept. of Geophysics, N. KRISHNA BRAHMAM.  
Andhra University,  
Waltair, May 25, 1963.

1. Krishna Brahmam, N., *Ph D. Thesis submitted to the Andhra University in 1962.*
2. Mooney, H. M., *Geophysics*, 1952, 17, 531.

## POLYPHENOLS OF PSIDIUM GUAIJAVA PLANT

THE guava tree is grown mostly for its fruit; however its leaves and bark have been used for dyeing and tanning and as vegetable drugs. Its fruits,<sup>1-6</sup> seed oil<sup>7-8</sup> and leaves<sup>9,10</sup> have been chemically examined in the past; the fruits are rich in vitamin C. Soliman and Farid<sup>9</sup> made a preliminary study of the leaves of the Egyptian plant and later, Khadem and Mohammed<sup>10</sup> reported the presence of three anti-bacterial compounds, namely quercetin and two isomeric glycosides avicularin and guaijaverin; both are 3-o-arabinosides of quercetin and the difference lies only in the ring of the sugar which is furanose in the former and pyranose in the latter.

The present study of the different parts of the plant has been made in order to throw more light on the chemical components, which can be responsible for the uses mentioned above. A general procedure for extraction was applied to each of the parts. The material was extracted with ethanol in the cold. The concentrated extract was repeatedly washed with light petroleum in order to remove chlorophyll, waxy matter and other petroleum-soluble compounds. It was then extracted with ether continuously for removal of ether-soluble components. Later ethyl acetate extraction separated leucoanthocyanidins. The water-soluble compounds were finally isolated from the residue obtained after evaporating the mother liquor completely over potash at room temperature.

Polyphenols occur in good quantities in the leaves, stem and root-barks and also in the fruits. Quercetin is found in the leaves in the form of its arabinoside guaijaverin, m.p. 240° C. The isomeric compound avicularin is not found in the samples we have examined. On the other hand leucocyanidins are found in all parts of the plant. They all have the same  $R_f$  and give cyanidin on boiling with alcoholic hydrochloric acid; but they exhibit differences in physical properties depending on the parts from which they are obtained. These are listed below, and may arise from the presence of different proportions of stereoisomers. Such an observation has already been made in connection with other plant sources.<sup>11,12</sup>

(*ea* = ethylacetate; *py* = pyridine)

**Leucocyanidin.**—(1) from leaves: Acetate, m.p. 184–186°, ( $\alpha$ )<sub>D</sub><sup>32</sup> + 15.3 (*ea*). Methyl ether soluble in ordinary organic solvents, m.p. 155–158°, ( $\alpha$ )<sub>D</sub><sup>33.8</sup> + 13.9 (*ea*); (2) from stem-bark: Acetate, m.p. 180–183°, ( $\alpha$ )<sub>D</sub><sup>30</sup> + 74.7 (*ea*). Two methyl ethers, (A) m.p. 270–272°, sparingly soluble in organic solvents except hot pyridine, and (B) readily soluble in organic solvents, m.p. 159–160°, ( $\alpha$ )<sub>D</sub><sup>30</sup> + 25.7 (*ea*). (3) from root-bark: Two methyl ethers; (A) sparingly soluble in organic solvents except pyridine, m.p. 275–276°, ( $\alpha$ )<sub>D</sub><sup>30</sup> 89.2 (*py*), giving methyl cyanidin only on long boiling with alcoholic hydrochloric acid; (B) readily soluble in common organic solvents, m.p. 155–158°, ( $\alpha$ )<sub>D</sub><sup>30</sup> + 11.8 (*ea*), giving methyl cyanidin even in the cold with alcoholic hydrochloric acid.

The leucocyanidins may account for the marked astringent and other medicinal properties of the different parts of the plant. But a prominent part seems to be played by gallic acid derivatives also. Gallotannin is present in good yield in the root-bark. In the leaves and ripe fruits ellagic acid is prominently present. The leaves and stem-bark are rich in a diglucoside of ellagic acid which crystallises from aqueous alcohol as rectangular plates, m.p. 248° (decomp.), ( $\alpha$ )<sub>D</sub><sup>25</sup> –41.4 (*py*). It is sparingly soluble in organic solvents and soluble in water and is markedly astringent. Its acetate crystallises from ethyl acetate as colourless small prisms, m.p. 208–210° ( $\alpha$ )<sub>D</sub><sup>25</sup> + 91.6° (*ea*). After complete methylation and hydrolysis a trimethyl ether of ellagic acid is obtained, m.p. 293–94° and it is found to be identical with 3 : 3' : 4'-trimethyl ellagic acid by mixed m.p., chromatography and I.R. spectrum. Consequently the glycoside carries a single

disaccharose unit in the 4 position. Though the presence of ellagic acid glycosides has been surmised in different plant sources the present report seems to be the first with regard to its isolation and characterisation.

We convey thanks to the C.S.I.R. and U.G.C. for the grant of fellowship to one of us (K. V.).

Department of Chemistry, T. R. SESHADRI.  
Delhi University, (MISS) K. VASISITA.  
October 22, 1963.

1. Miller and Robbins, *Hawaii Agric. Exp. Stat. Bull.*, 1934, **35**, 25.
2. Ranganathan, *Ind. J. Med. Res.*, 1935, **23**, 239.
3. Goldberg and Levy, *Nature*, 1941, **148**, 286; *J.S. Afr. Chem. Inst.*, 1942, **25**, 3.
4. Webber, *Proc. Amer. Soc. Hort. Sci.*, 1944, **45**, 87.
5. Quinones, Guerrant and Dutcher, *Food Res.*, 1944, **9**, 415.
6. Hartzler, *J. Nutrition*, 1945, **30**, 355.
7. Kinzo, Kafuku Hata and Massaiichi, *J. Chem. Soc. Japan*, 1934, **55**, 373.
8. Varma, Godbole and Srivastava, *Pettechem*, 1936, **43**, 8.
9. Soliman and Farid, *J. Chem. Soc.*, 1952, 134.
10. Khadem and Mohammed, *Ibid.*, 1958, 3320.
11. Nagarajan and Seshadri, *J. Sci. and Ind. Res. (India)*, 1961, **20 B**, 615.
12. Chadha and Seshadri, *Curr. Sci.*, 1962, **31**, 56.

#### STUDIES ON COMPLEX FORMATION OF QUINOLINE WITH PERCHLORATES OF SOME BIVALENT METALS

The quinoline complexes of zinc, cadmium, mercury, copper, nickel and cobalt have been prepared. The metal perchlorates in each case were dissolved in an excess of freshly distilled quinoline. The thick viscous solution was gently warmed for some time to ensure complete reaction and left overnight in a desiccator. The excess of quinoline was then removed by washing with acetone or chloroform and dried in desiccator.

For estimation of quinoline in the white complex compounds a weighed quantity of the substance was dissolved in a measured volume of standard hydrochloric acid and the solution made up to 250 c.c. Aliquot parts of this solution were titrated against standard alkali using screened indicator (methyl orange + methylene blue) and from the titration data the amount of quinoline was calculated.

In order to estimate the quantity of quinoline in coloured complexes such as those of Hg, Cu, Ni, and Co, excess of NaOH and some water were added to a weighed amount of the substance. The quinoline from this was removed by steam distillation and collected in a known

TABLE I

Compound		Found (%)	Calculated (%)	Property
(1) Zn (ClO <sub>4</sub> ) <sub>2</sub> ·3Qn	..	Zn 9.9 Qn 59.6 (ClO <sub>4</sub> ) <sub>2</sub> 30.5	9.9 59.4 30.67	White to reddish-brown crystals. Fairly stable in air.
(2) 2Cd (ClO <sub>4</sub> ) <sub>2</sub> ·5Qn	..	Cd 17.7 Qn 50.4 (ClO <sub>4</sub> ) <sub>2</sub> 31.9	17.7 50.9 31.4	White powder, hygroscopic, stable in air.
(3) Hg (ClO <sub>4</sub> ) <sub>2</sub> ·5Qn	..	Hg 19.3 Qn 62.5 (ClO <sub>4</sub> ) <sub>2</sub> 18.3	19.2 61.7 19.05	Dark grey mass, very hygroscopic. Decomposed on exposure to air.
(4) Cu (ClO <sub>4</sub> ) <sub>2</sub> ·3Qn	..	Cu 9.4 Qn 60.0 (ClO <sub>4</sub> ) <sub>2</sub> 30.8	9.77 59.5 30.79	Pale black powder. Not hygroscopic.
(5) Ni (ClO <sub>4</sub> ) <sub>2</sub> ·5Qn	..	Ni 7.2 Qn 71.2 (ClO <sub>4</sub> ) <sub>2</sub> 21.6	6.6 71.4 22.0	Dark blue powder. Not very hygroscopic.
(6) Co (ClO <sub>4</sub> ) <sub>2</sub> ·4Qn	..	Co 7.8 Qn 66.2 (ClO <sub>4</sub> ) <sub>2</sub> 26.0	7.6 66.6 25.7	Almost black powder. Not very hygroscopic.

volume of standard HCl. This was made up to 250 c.c. and aliquot parts titrated against standard NaOH, as in above, to get the amount of quinoline present. The solid residue left in the flask after steam distillation was dissolved in acid and the solution diluted to 250 c.c. The metal in the solution was estimated by usual methods.

Attempts were made to estimate perchlorate as KClO<sub>4</sub> but concordant results were not obtained. The dry methods of estimation could not be resorted to, as the compounds exploded when heated. Since the compounds did not contain any water, the perchlorate was, therefore, obtained by difference from the values of the percentage of quinoline and the metal in the compound.

Zinc and cadmium were estimated as pyrophosphates. Copper was estimated iodometrically and nickel by precipitation with dimethylglyoxime. Mercury and cobalt were estimated by electrodeposition.

The results of analysis of the complex compounds (mean of three values in the case of the metal and quinoline) and their properties in brief are given in Table I.

In Table I, all the compounds decomposed by acids and were insoluble in acetone, ether, and chloroform.

Department of Chemistry,  
Patna University,  
Patna-5, June 11, 1963.

P. C. SINHA.  
B. N. SAHAJ.

#### ACCUMULATION OF POLY- β-HYDROXYBUTYRIC ACID AND IODOPHILIC MATERIAL BY THE DOMINANT ACTIVATED SLUDGE BACTERIA

DURING a survey of the bacterial flora of activated sludge it was observed that 52% of the dominant bacteria (isolated by plating sludge on plates of sewage solidified with agar) contained sudanophilic inclusions. This suggested the possibility that these bacteria accumulated poly-β-hydroxybutyric acid (PHB), a reserve substance known to occur in various bacteria.<sup>1-9</sup> The occurrence of this polymer in a large portion of the activated sludge flora was considered interesting in view of the well-known ability of activated sludge to store organic material during the initial stages of wastewater treatment, a phenomenon generally referred to as "adsorption". Accordingly, experiments were conducted to see if the dominant activated sludge bacteria contained PHB.

Twelve strains belonging to the genera *Zoogloea* and *Comamonas*<sup>10</sup> were grown in a peptone medium containing 0.5% each of glycerol and sodium succinate. The cells were harvested separately, dried at 110° C. and then extracted with boiling chloroform. The extracts were diluted with four volumes of ethyl ether and left at 4° C. overnight. The flocculent precipitate from each was filtered off, washed with boiling ether, and dried to constant weight. It was observed that all the bacteria tested

contained chloroform-soluble, ether-insoluble material in amounts varying from 6.66 to 51.51%. The material isolated from different bacteria had melting points varying from 156° to 172°C. and this is in accord with past records.<sup>1-6</sup> On heating to temperatures beyond the melting point, copious white fumes with an odour of crotonic acid were produced and these condensed on the cooler parts of the tube as needle-shaped crystals. These results, taken in conjunction with the sudanophilic nature of the inclusions, leave little doubt as to the identity of the isolated substance with PHB. In two instances (a *Zoogaea* and *Comamonas*) the melting point of the material obtained on destructive distillation of the chloroform-soluble, ether-insoluble substance was determined and was found to agree with the value recorded for *trans*-crotonic acid.<sup>6</sup> The chloroform-soluble, ether-insoluble bacterial constituent was insoluble in water, ethanol, acetone and dilute mineral acids but was soluble in N-sodium hydroxide.<sup>2</sup>

The above results suggest the possibility that the initial rapid removal of organic matter during activated sludge treatment of waste-water represents a conversion of at least a good portion of the organic matter into substances such as PHB, glycogen, starch, etc., rather than "adsorption" in the physical sense. However, the extent to which PHB acts in this manner has not been ascertained. It is significant to observe, however, that PHB has also been detected in activated sludge.

Another observation of interest in the above context of storage functions was the finding that 32% of the sludge isolates when grown on media containing starch accumulated an iodophilic substance in a manner similar to that described by Carrier and McCleskey<sup>11</sup> for certain *Corynebacterium* species. Iodophilia was not observed in cells grown in media containing various other carbohydrates or glucose-1-phosphate.

In conclusion it may be mentioned that as far as the present authors are aware there is no previous record on the selection of PHB-producing bacteria in any ecosystem as witnessed in the activated sludge. Bacteria accumulating iodophilic polysaccharide from a variety of sugars have been known to occur in the rumen.<sup>12-14</sup> The selection of bacteria with a storage function is probably a manifestation of the meagre food resources of the ecosystem and it is reasonable to assume that in a system, like activated sludge where food is in short supply,

bacteria with storage functions would thrive better and longer.

A detailed report on the methods of isolation and the nature of the dominant activated sludge bacteria will be published elsewhere.

Indian Institute of Science, F. F. DIAS.  
Fermentation Technology Lab., J. V. BHAT.  
Bangalore-12, October 17, 1963.

1. Lemoigne, M., *Ann. Inst. Pasteur*, 1927, **41**, 148.
2. Williamson, D. H. and Wilkinson, J. G., *J. Gen. Microbiol.*, 1958, **19**, 198.
3. Forsyth, W. G. C., Hayward, A. C. and Roberts, J. B., *Nature, Lond.*, 1958, **182**, 800.
4. Hayward, A. C., Forsyth, W. G. C. and Roberts, J. B., *J. Gen. Microbiol.*, 1959, **20**, 510.
5. Doudoroff, M. and Stanier, R. Y., *Nature, Lond.*, 1959, **183**, 1440.
6. Levine, H. B. and Wolochow, H., *J. Bacteriol.*, 1960, **79**, 595.
7. Schlegel, H. G., Gottschalk, G. and Bartha, R., *Nature, Lond.*, 1961, **191**, 463.
8. Rouff, M. A. and Stokes, J. L., *J. Bacteriol.*, 1962, **83**, 343.
9. Sierra, G. and Gibbons, N. E., *Canadian J. Microbiol.*, 1962, **8**, 249.
10. Davis, G. H. G. and Park, R. W. A., *J. Gen. Microbiol.*, 1962, **27**, 101.
11. Carrier, E. B. and McCleskey, C. S., *J. Bacteriol.*, 1962, **83**, 1029.
12. Barker, F., *Nature, Lond.*, 1942, **149**, 220.
13. Doetsch, R. N., Robinson, R. Q., Brown, R. E. and Shaw, J. C., *J. Dairy Sci.*, 1953, **36**, 825.
14. Gibbons, R. J., Doetsch, R. N. and Shaw, J. C., *Ibid.*, 1955, **38**, 1147.

#### CHEMICAL STUDY OF THE INDIGENOUS PLANT *SARACA INDICA* (ASOKA)

THE indigenous medicinal plant *Saraca indica* (ver.: Asoka), which grows abundantly in South India, Arakan, Tenassarim, East Bengal and in U.P., has been in extensive use in Ayurvedic system of medicine for a variety of ailments. Its use in the treatment of menstrual disorder, especially in conditions of menorrhagia, attracted the attention of modern investigators since a long time and quite a considerable study on the clinical trial, pharmacological evaluation and chemical composition of the plant has been undertaken. Results, hitherto obtained, revealed that while the crude alcoholic extract of the plant could exert clinical effect in menstrual disorders and could also exert stimulating effect on the isolated uterus, making the contractions more frequent and prolonged without producing tonic contractions (Adlya and Roy), the plant was not found to contain any such active principle, which could account for these clinical and pharmacological effects.

Hæmatoxylin, tannin, and organic iron compound were the only principles which could be detected and isolated (Chopra).

A systematic chemical study of the plant shows that the plant contains a Ketosterol (m.p. 25° C.), a glycosidal fraction, a saponin ( $C_{10}H_{21}O_{14}$ ), an organic calcium compound ( $C_6H_{10}O_5Ca$ ), besides the principles already reported. The clinical response, observed by earlier workers, in the treatment of menorrhagia might, therefore, be due to the presence of Ketosterol, which seems to be androgenic in nature and the organic calcium salt, which exert their effects on the functional disorder rather than any direct effect on the uterine muscles. The pharmacological response observed seems to be due to the presence of the steroidal fraction and calcium salt.

Clinical Biochemist,  
College of Medical Sciences,  
Banaras Hindu University,  
Varanasi-5, April 6, 1963.

S. P. SEN.

1. Adya P. and Roy, B. B., *J Ind. med. Assoc.*, April 1940.
2. Chopra, R. N., *Indigenous Drugs of India*, 1938, p. 376.

#### A SPECTROPHOTOMETRIC METHOD FOR THE DETECTION OF BUFFALO MILK IN COW MILK

Cow MILK lends itself easily to adulteration with buffalo milk diluted with water difficult of detection, because the latter contains larger quantities of the major constituents namely fat, proteins and lactose.<sup>1</sup> Apart from the serological test developed in this Institute,<sup>2</sup> there does not seem to be any other chemical method available to detect the adulteration of cow milk with buffalo milk. Carotene, a minor constituent, is present only in cow milk and imparts to it a yellowish colour. The presence of 5 to 10% of cow milk in buffalo milk can be easily detected by extracting the colouring material by ether solvent and comparing it with a standard colour solution.<sup>3</sup> This method based on the carotene content cannot be applied for the detection of buffalo milk in cow milk because of its wide variation in cow milk caused by feed, season, breed and period of lactation. It was, however, observed that the characteristic spectra of the solvent extract of cow milk differs significantly from that of buffalo milk and a method based on this difference has been developed to detect the presence of buffalo milk in cow milk.

The carotenes present in cow milk were extracted according to the principle of Rose-Gottlieb method<sup>4</sup> with certain modifications. 50 ml. of milk samples was mixed thoroughly with 5 ml. of liquor ammonia in a separatory funnel. 25 ml. of ethyl alcohol was added and mixed well. 50 ml. of a mixture of ethyl ether and light petroleum ether (1:1) was then added and the mixture shaken vigorously. The lower aqueous layer was discarded and the ethereal layer was evaporated to dryness. The residue was re-extracted with a small amount of ethyl ether and filtered through cotton wool. The filtrate was made up to 10 ml. with ethyl ether. A similar procedure was adopted for the extraction of the buffalo milk and the mixtures of cow and buffalo milk.

The extracts obtained were analysed spectrophotometrically between 360 m $\mu$  and 460 m $\mu$  using a Beckman Spectrophotometer Model DU.

The spectra of the solvent extract from cow milk showed an absorption maximum at 454 m $\mu$  (Fig. 1, a), which is characteristic of  $\beta$ -carotene

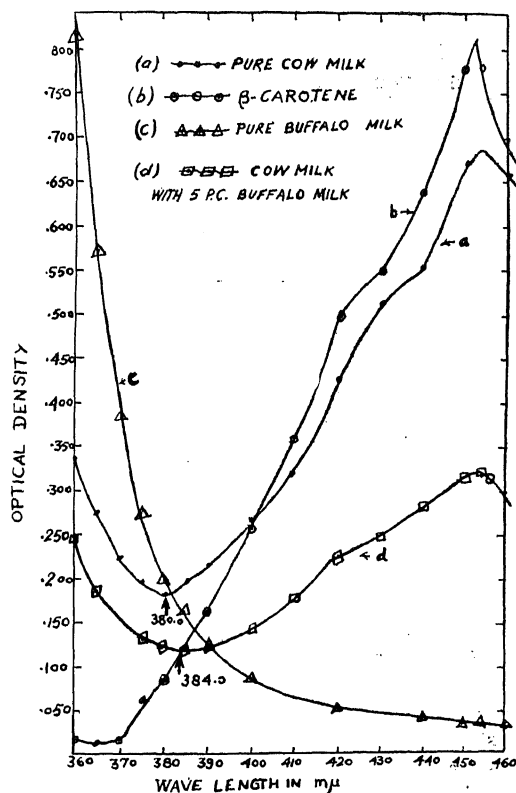


FIG. 1. Absorption spectra of diethyl ether extracts. in ethyl ether (Fig. 1, b). The extract was also found to show an absorption minimum at 380 m $\mu$ .

The carotene itself did not exhibit any clear absorption minimum in the region studied. Cow milk diluted with water or mixed with  $\beta$ -carotene gave a spectrum similar to that of pure cow milk.

The extract of pure buffalo milk did not show an absorption minimum at  $380\text{ m}\mu$  nor an absorption maximum at  $454\text{ m}\mu$  (Fig. 1, c).

The spectra of the extracts of the mixtures of cow and buffalo milk resembled those of cow milk in so far as the absorption maximum at  $454\text{ m}\mu$  was concerned. It was, however, observed that there was a shift in the absorption minimum from  $380\text{ m}\mu$  to the longer wavelength side (Fig. 1, d), which depended on the proportion of the buffalo milk present in the mixture.

The authors wish to express their thanks to Dr. K. K. Iya and Dr. N. C. Ganguli for their suggestions and encouragement.

Dairy Chem. Division, N. K. Roy.

National Dairy Res. Inst., V. R. BHALERAO.  
Karnal (Punjab), April 8, 1963.

1. Basu, K. P., *et al.*, *I.C.A.R. Report Series No. 8: Composition of Milk and Ghee*, I.C.A.R. Publication, 1962.
2. Nair, P. G. and Iya, K. K., *Milchwissenschaft*, 1962, **17**, 477.
3. Roy, N. K., *Annual Report of National Dairy Research Institute, Karnal (Punjab)*, 1962.
4. *Rose-Gottlieb Method, Determination of Fat: Indian Standard Methods for Test for Dairy Industry—I.S. 1479 (Part II)*, Indian Standards Institute Publication, 1961.

### MANTLED FELSPARS IN ANJANA GNEISSES NEAR DEOGARH (RAJASTHAN)

AUGEN gneisses of granodiorite composition are well exposed like a dome-shaped boss at Anjana and spread over a vast area east of Deogarh<sup>1</sup> ( $25^{\circ} 32' : 73^{\circ} 57'$ ). The gneisses are predominantly biotitic with a random distribution of sparse quartzofelspathic material as incipient orbicules or small granular patches giving a mottled appearance and crude foliation. Towards Anjana these gneisses become well foliated and acquire a progressive augen structure to perfection. Parallel to the foliation of the gneisses, pockets of quartz biotite schist are observed here and there. These schistose pockets appear to be relict patches in the migmatized region. Pegmatites ranging in size from pod-like bodies to dike-like masses occur throughout this migmatite area. A striking feature of these pegmatites and the associated

quartz veins is the pygmatic folding—a feature normal to regions of granitisation.<sup>2</sup>

The gneiss is mostly a quartz-oligoclase-microcline-biotite one with accessory hornblende. Biotite is strongly pleochroic and shows genetic relationship with hornblende which occurs as a relict mineral surrounded by a swarm of brown biotite laths having crystallographic continuity with it. The felspar augen usually measuring  $5 \times 3\text{ cm.}$  are much elongated parallel to the gneissic foliation. The folia of the biotite schist swirl round the felspar porphyroblasts. It appears as if the growing felspars have made room for their growth by pushing aside the schistose bands. A significant feature is that these augen display a mantle texture with a grey core and pink rim. The plagioclase gives a turbid appearance due to intense seicitisation and presence of scattered brown ferruginous dust and minute flaky inclusions of biotite. It occurs as large porphyroblasts in a mesostasis of quartz, oligoclase, biotite and chlorite and also as glomeroblastic aggregates. It usually twins on the albite law and has the composition Ab 80–75%. Microcline is remarkably fresh and is often found in replacement relation with plagioclase. The plagioclases display different degrees of replacement and when completely enveloped by microcline, a mantle texture is formed round plagioclase (Fig. 1). The contact between them



FIG. 1. Mantle texture with a core of oligoclase and a rim of microcline. Note also the irregular contact with blebs of quartz.

in such cases is irregular and often marked by quartz blebs and myrmekite growth. When such contact is well defined or sharp, it probably represents an arrested stage of replacement.<sup>3</sup> These mantled felspars are a unique feature of the Anjana gneisses not hitherto reported.<sup>4</sup> The invariable association of biotite and



plagioclase and the frequent replacement of the former by the latter is a textural feature observed in most of the sections. During this replacement, sericite released as a by-product imparts turbidity to the plagioclase. In the next stage of replacement it is the fixing up of this sericite in the plagioclase lattice that heralds the process of microclinalisation of plagioclase. This transformation when caught in the act shows, in striking contrast, the turbid remnant plagioclase and the remarkably fresh and clear replacing microcline.

From the foregoing details two salient features stand out prominent. One is the development of plagioclase as the first step and the second is the replacement of plagioclase by microcline. These metasomatic events point to a soda metasomatism (front) followed by a potash metasomatism. All evidence speaks in favour of a metasomatic origin of the mantled texture in feldspars in the Anjana gneisses.

The author desires to express his grateful thanks to Dr. S. Balakrishna for his valuable guidance and helpful criticism in preparing this paper.

Department of Geology, P. V. SOMAYAJULU.  
Osmania University,  
Hyderabad-7, A.P. (India), May 17, 1963.

1. Heron, A. M., *Memoir G.S.I.*, 1953, 79.
2. Ramburg Hars, *The Origin of Metamorphic and Metasomatic Rocks*, University of Chicago Press, 1952.
3. Read, H. H., *The Granite Controversy*, 1956.
4. Gupta, B. C., *Memoir G.S.I.*, 1934, 65, Part 2.

#### TEXTURAL PECULIARITY IN A DOLERITE DYKE NEAR KADAKOLA, MYSORE

A prominent dolerite dyke runs from Sindhuvali to Doddakanya, near Kadakola about seven miles to the south of Mysore. The dyke can be traced almost in a north-south direction for nearly three miles. It intrudes into greasy grey granitic gneisses and pyroxene-granulites, thus being exposed in a charnockitic and ultrabasic geological setting.

Microsections of this dolerite dyke show the presence of plagioclase, ortho- and clino-pyroxenes and olivine with interesting relationship among one another. Plagioclases which are mostly twinned occur both as lath-shaped crystals and as broad plates. The twin laws as determined by Reinhard's method reveal complex Albite-Carlsbad, Albite, Carlsbad, and Complex Manebach-Ala types. The anorthite

content varies from 52-60% suggesting the feldspar to be labradorite. The feldspar is clouded with inclusions concentrated in the centre leaving the margins clear.

Clino- and ortho-pyroxenes occur as tabular and prismatic crystals, twins being quite common in clino-pyroxenes. The clino-pyroxene, augite, shows the following optical characters:

$$+2V = 50 \pm 1^\circ \text{ (average of 12 readings)}$$

$$Z \Delta c = 43^\circ \text{ (average of 10 values)}$$

Birefringence (average) = .028 (using Berek Compensator). Some grains are feebly pleochroic from pale green to pale greenish-pink.

Ortho-pyroxenes consist mainly of hypersthene often filled with schiller inclusions. The optical properties are as follows:

$$-2V = 76^\circ - 80^\circ$$

$$\text{Birefringence} = .009 - .016$$

X = Brick red

Y = Pale yellow

Z = Pale green

Olivine is quite common and occurs in more or less rounded, colourless crystals. It is often bordered by reaction rims of rhombic pyroxene and fibrous hornblende thus presenting a corona structure. Besides these constituents, biotite and iron ores occur as accessory minerals.

In thin sections, the plagioclase feldspars are found to enclose partially and in some cases completely, euhedral crystals of pyroxenes which in turn often enclose olivine (Fig. 1). Surya-

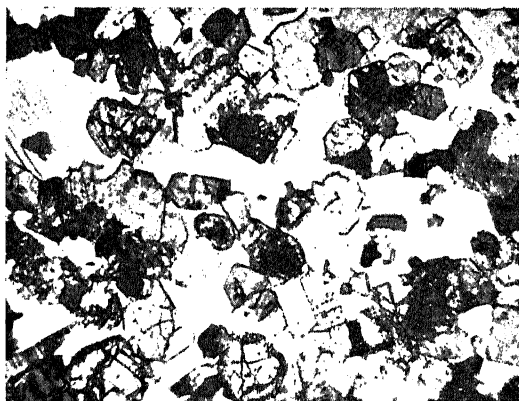


FIG. 1. Twinned plagioclases enclosing smaller euhedral grains of pyroxenes and olivines. Both partial and complete enclosure may be noticed. Crossed nicols,  $\times 20$ .

narayana (1961) has reported plagioclase poikilitically enclosing crushed augite grains in the augite-diorites of Closepet area. But the dolerite near Kadakola exhibits poikilitic

texture which might have directly resulted from fractional crystallisation. Idiomorphism of the pyroxenes enclosed in plagioclase and the calci-alkalic composition of the plagioclase (An 52-60%) indicate later crystallisation of the feldspar.

Our grateful thanks are due to Prof. M. N. Viswanathiah and Dr. B. V. Govinda Rajulu for their encouragement and guidance in the preparation of this article.

Department of Geology, C. PRASADA RAO.  
University of Mysore, D. NARASIMHA MURTHY.  
Manasa Gangotri,  
Mysore-2, May 31, 1963.

1. Suryanarayana, K. V., "Textural variation in the Dolerite Dykes of Closepet area," *Indian Mineralogist*, 1961, 2 (2), 5.

**ON THE OCCURRENCE OF  
PHOLADOMYA cf. ELLIPTICA  
MÜNSTER AND PHOLADOMYA cf.  
INDICA NOETLING FROM THE BAGH  
BEDS OF MADHYA PRADESH**

THE genus *Pholadomya*, represented by two species, *P. cf. P. elliptica* Münster and *P. cf. P. indica* Noetling, is being reported from the Upper Cretaceous Bagh Beds of Madhya Pradesh. The specimens were collected from the type area of these formations. A detailed study of the Bagh fauna was made by Duncan (1865, 1887),

Vredenburg (1907, 1908), Fourteau (1918), and Chiplonker (1937, 1938, 1939, 1941). This particular find is significant as it lends support to the observation made by Chiplonker (1942) that "the fossil fauna of the Narbada valley belongs to the Mediterranean Zoological province and had no direct connection with that of the southern ocean".

**SYSTEMATIC DESCRIPTION**

Phylum	MOLLUSCA
Class	PELECYPODA
Order	DESMODONTA
Family	PHOLADOMIDÆ
Genus	<i>PHOLADOMYA</i> Sow.

*Pholadomya* sp. cf. *P. elliptica* MÜNSTER

Plate I, Figs. 1 a, 1 b

**Description.**—Shell equivalved, very inequilateral; umbos situated almost anteriorly; transversely oval in outline; highest anteriorly. Anterior side highly inflated; posterior compressed and gaping. Both anterior and posterior rounded. Dorsal margin concave, ventral convex. Surface with a number of radial ribs and concentric growth lines. The actual number of these cannot be ascertained because of poor state of preservation.

**Dimensions.**—Length—70 mm.; height—55 mm.

**Remarks.**—The Bagh specimen has been compared with the species described by Rennie (1930) from the Upper Cretaceous of Pondo-



Fig. 1a



Fig. 1b

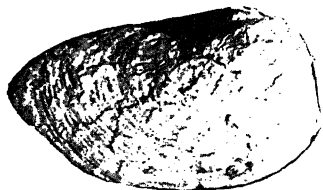


Fig. 2

FIGS. 1-2. Fig. 1a. *Pholadomya* cf. *elliptica* Münster showing right valve. Natural size. Fig. 1b. Umbonal view of the same. Natural size. Fig. 2. *Pholadomya* cf. *indica* Noetling showing left valve. Natural size.

land with which it resembles very closely in shape and ornamentation. The type specimen *P. elliptica* Münster (as mentioned by Rennie) is found abundantly in the Senonian of N. Africa, France and Europe.

*Horizon*.—? Nodular limestone.

*Locality*.—Bariah.

*Pholadomya* sp. cf. *P. indica* NOETLING

There is a complete, poorly preserved specimen in my collection which has been compared with *Pholadomya indica* Noetling, described from the Upper Cretaceous of Baluchistan, with which it resembles closely in shape and ornamentation. The Bagh specimen is slightly bigger in size. It is quite distinct from the previous species.

*Dimensions*.—Length—63 mm.; height—34 mm.

*Horizon*.—Nodular limestone.

*Locality*.—Deora (Deola).

The author expresses his thanks to Prof. M. R. Sahni for his guidance and to Prof. P. R. J. Naidu for kindly going through the manuscript. Thanks are also due to the Director-General, Geological Survey of India, and to the University Grants Commission for financial assistance.

Department of Geology, S. P. JAIN.  
Punjab University,  
Chandigarh-3, May 2, 1963.

1. Chiplonker, G. W., *Proc. Ind. Acad. Sci.*, 1937, 6 B (1), 60.
2. —, *Ibid.*, 1938, 7 (6), 400.
3. —, *Ibid.*, 1939 a, 9 (5), 236.
4. —, *Ibid.*, 1939 b, 10 (1), 98.
5. —, *Ibid.*, 1939 c, 10 (4), 255.
6. —, *Ibid.*, 1941, 14 (3), 271.
7. —, *Ibid.*, 1942, 15 (3), 148.
8. Duncan, P. M., *Q. J. G. S.*, 1865, 21, 349.
9. —, *Rec. G.S.I.*, 1887, 20, 81.
10. Forteau, R., *Ibid.*, 1918, 49, Part 1, 34.
11. Noetling, F., *Pal. Ind.*, 1897, 1 (14), Part 3.
12. Rennie, J. V. L., *Ann. S. Afr. Mus.*, 1930, 28, 159.
13. Vredenburg, E., *Rec. G.S.I.*, 1907, 36, Part 2, 109.
14. —, *Ibid.*, 1908, 36, Part 3, 239.

### COPPER AND MANGANESE CONTENTS OF A FEW FORAGE PLANTS OF WESTERN INDIA

PRELIMINARY studies were carried out to determine the copper and manganese contents of a few characteristic forage species collected at the flowering and fruiting stages, from the extensive grasslands at Talegaon, 90 miles south of Bombay. Analysis was made on triplicate samples by the methods of Piper<sup>2</sup> and the average data are presented in Table I.

TABLE I

Average copper and manganese contents of some  
Indian forage plants  
(p.p.m. of dry matter)

Name of species	Copper		Manganese	
	Flowering	Fruiting	Flowering	Fruiting
1. <i>Ischamum ciliare</i> Retz. ..	4.8	0.9	80.9	11.0
2. <i>Heteropogon contortus</i> L. ..	2.4	1.0	52.4	13.3
3. <i>Themeda triandra</i> Forsk. ..	5.6	1.2	28.6	9.8
4. <i>Themeda quadrivalvis</i> OK... ..	5.3	1.6	30.2	16.5
5. <i>Pseudanthistiria heteroclita</i> Hk. ..	3.4	0.9	38.1	11.2
6. <i>Arundinella tenella</i> LAWII..	4.8	1.2	19.0	5.4
7. <i>Dichanthium annulatum</i> Stapf. ..	3.8	1.9	32.1	10.1
8. <i>Eulalia fimbriata</i> Bl. and Mc. ..	4.3	0.9	42.3	8.6
9. <i>Indigofera tinctoria</i> L. ..	12.6	5.4	57.1	15.4
10. <i>Heylandia latebrosa</i> DC. ..	7.9	5.4	38.1	9.8
11. <i>Crotalaria linifolia</i> Linn. ..	7.8	2.6	33.3	9.4
12. <i>Crotalaria triquetra</i> Dalz. ..	5.6	1.8	48.5	12.4
13. <i>Crotalaria filipes</i> Benth. ..	6.8	1.2	41.3	14.1
14. <i>Smithia sensitiva</i> Ait. ..	5.8	2.5	41.6	10.6
15. <i>Alysicarpus vaginalis</i> DC. ..	6.8	2.2	52.1	10.2
16. <i>Alysicarpus pubescens</i> Law ..	6.3	3.6	62.8	12.5

Grasses (samples 1 to 8) are seen to contain 2.4 to 5.6 p.p.m. copper with an average of 4.3 p.p.m. at the flowering stage and 0.9 to 1.6 p.p.m. copper with an average of 1.2 p.p.m. at the fruiting stage. Legumes contain nearly double the amounts of copper with average contents of 7.5 and 3.1 p.p.m. respectively. Such low amounts of copper in the forage species are due to the low available contents of copper in the soils (0.13 to 0.90 p.p.m.), the availability being further depressed by the alkalinity (soil pH 6.93 to 7.90 p.p.m.) and high amounts of calcium carbonate (3.2 to 7.8%). Steenbjerg and Ekman<sup>1</sup> have also shown that on soils deficient in copper the grasses contain less copper than legumes growing on the same soils. Price *et al.*,<sup>3</sup> however, state that grasses concentrate copper as effectively as legumes.

Both grasses and legumes contain sufficient amounts of manganese at the flowering stage but are deficient in it at the fruiting stage. Generally grasses are stated to contain more manganese than legumes but our data show that legumes contain more manganese which is probably due to their inherent capacity for manganese uptake. Thomas *et al.*<sup>5</sup> have also shown that both herbs and legumes contain more manganese than grasses. According to Kehar and Sahai<sup>1</sup> the minimum copper and manganese requirements for live-stock in India are 6.69

and 37.54 p.p.m. for adult non-producing cattle and 6.3 and 53.56 p.p.m. for sheep respectively. Our data show that at the mature stage, all the forage species are deficient in manganese while grasses are deficient in copper even at the flowering stage. Although legumes are seen to contain adequate amounts of copper at the flowering stage, their percentage composition in the grasslands is low, and the stock requirements of these two micronutrients cannot be met with by the forage.

Institute of Science, (Miss) JAYA G. IYER.  
Bombay-1, April 3, 1963. Y. SATYANARAYAN.\*

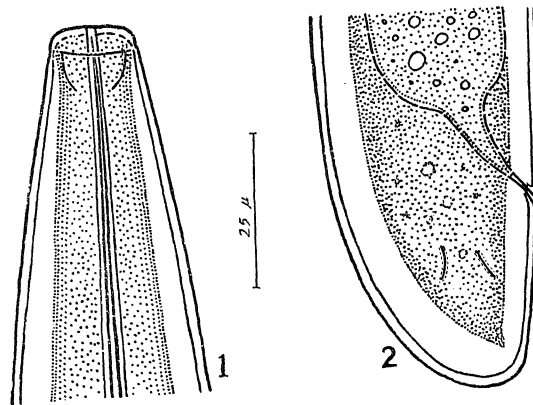
\* Present address: Central Arid Zone Research Institute, Jodhpur.

1. Kehar, N. D. and Sahai, K., *Bull. natl. Inst. Sci. India*, 1956, **8**, 113.
2. Piper, C. S., *Soil and Plant Analysis*, Waite Agric. Res. Inst., Adelaide, 1944.
3. Price, N. O., Linkous, W. N. and Engle, R. W., *J. Agric. Food Chem.*, 1955, **3**, 225.
4. Steenbjerg, F. and Ekman, P., *Soils and Fert.*, 1948, **12**, 110.
5. Thomas, B., Thompson, A., Oyenuga, V. A. and Armstrong, R. H., *Emp. J. Expt. Agric.*, 1952, **20**, 10.

**XIPHINEMA BREVICOLLE LORDELLO AND DA COSTA, 1961 : (NEMATODA: DORYLAIMOIDEA) FROM DALHOUSIE (H.P.), NORTH INDIA**

The species of the genus *Xiphinema* Cobb, 1913, are important phytoparasites throughout the world. It has been proved<sup>1-11</sup> that they cause serious damage to various plants as ectoparasites and also spread viral diseases. Only five species, *Xiphinema americanum* Cobb, 1913, *X. insignis* Loos, 1949, *X. pratense* Loos, 1949, *X. basiri* Siddiqi, 1959 and *X. opisthohysterum* Siddiqi, 1961, have so far been reported from India. Soil samples collected from around the roots of barberry, *Berberis* sp., from Dalhousie (H.P.) yielded large number of female specimens of *Xiphinema* which upon detailed study were found to agree closely with the description and measurements of *X. brevicolle* Lordello and Da Costa, 1961; a species recently reported from Brazil from soil around the roots of coffee trees, *Coffea arabica* var. *laurina*. However, there are some morphological variations in the present material when compared with the description of Lordello and Da Costa<sup>12</sup> (1961), but they are of the nature that they can only be regarded as intraspecific variations. In our material the lip region is more blunt and the tail is obtusely rounded. The triangular

cuticularized piece of the anterior slender portion of esophagus is not seen. The cardia are distinct and the praeectum and rectum clearly



FIGS. 1-2. *Xiphinema brevicolle* Lordello and Da Costa, 1961. Fig. 1. Anterior end. Fig. 2. Posterior end.

differentiated, the latter is about one anal body diameter, whereas the former is four times as long as the latter.

Dept. of Zoology, M. SHAMIM JAIKAPURI.  
Aligarh Muslim Univ., ATHER H. SIDDIQI.  
Aligarh (U.P.), India, April 5, 1963.

1. Adams, R. E., *Phytopath.*, 1955, **45** (9), 477.
2. Breece, J. R. and Hart, W. H., *Plant. Dis. Rept.*, 1959, **43**, 989.
3. Harrison, B. D. and Cadman, C. H., *Nature*, 1959, **184**, 1624.
4. Hewitt, W. B., Raski, D. J. and Goheen, A. C., *Phytopath.*, 1958, **48**, 586.
5. Jha, Asharfi and Posnette, *Nature*, 1959, **184**, 962.
6. Peacock, F. C., *Ibid.*, 1959, **184**, 123.
7. Perry, V. G., *Phytopath.*, 1958, **48** (8), 420.
8. Raski, D. J. and Hewitt, W. B., *Proc. IX Int. Bot. Congr.*, 1950, **11**, 319.
9. —, *Nematologica*, 1960, **5**, 166.
10. Schindler, A. F., *Phytopath.*, 1954, **44** (7), 389.
11. —, *Nematologica*, 1957, **2** (1), 25.
12. Lordello, L. G. E. and Costa, C. P. Da, *Rev. Brasil Biol.*, 1961, **21** (4), 363.

**POSTEMBRYONIC DEVELOPMENT OF PTEROTHORACIC SCLERITES IN DYSDERCUS KOENIGII (F.) (HEMIPTERA: PYRRHOCORIDAE)**

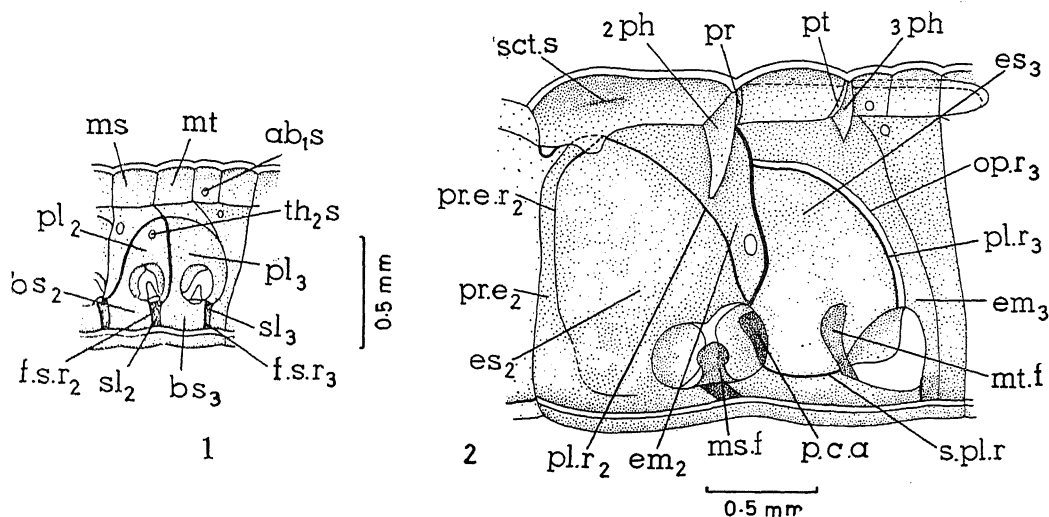
The skeletal system of meso- and metathoracic segments of *Dysdercus koenigii* undergoes marked changes during the postembryonic development. These changes involve an increase in size of the sclerites and their progressive differentiation into subregions.

In a newly hatched first instar nymph, the meso- and metathoracic segments are feebly sclerotized and are similar to the prothorax<sup>1</sup> in

size and general appearance. The meso- and metanotum are each formed of a single sclerotic plate, the *notum* (*ms*, *mt*), their junction being marked by a ridge-like inflection. In the second instar, the *second* (2. *ph*) and the *third phragmata* (3. *ph*) are developed. The third instar is characterised by the development of wing rudiments and the mesonotum becomes twice as long as the metanotum. In the fourth instar, rudiments of *scutellar sulcus* (*sct. s*) appear in the mesonotum and metanotum is marked by the differentiation of a *pretergite* (*pr*). In the fifth instar nymph the two scutellar sulci extend up to the posterior edge of the mesonotum and the *postnotum* (*pt*) appears in the metanotum. The final differentiation and elaboration of the remaining sclerites occurs during fifth ecdysis.

mesoscutellum belongs to the metanotum and should be regarded as its pretergite.

There has been some divergence of opinion concerning the identity of the scutoscuteellar junction in the mesonotum of heteropterous insects. In most species, a transverse sulcus running between the anterior and posterior notal wing process has been observed, which has been referred to as scutoscuteellar sulcus by some (Tower,<sup>2</sup> Taylor,<sup>3</sup> Malouf,<sup>4</sup> Akbar<sup>6</sup>) workers and transscutal sulcus by others (Larsén,<sup>7</sup> Greca,<sup>8</sup> Greca and Cesaro<sup>5</sup>, Khanna<sup>9</sup>). The present study of postembryonic development of *Dysdercus koenigii* reveals that it is the transscutal sulcus, although a distinct but incomplete scutoscuteellar sulcus is present situated just behind the transscutal sulcus.



FIGS. 1-2. Fig. 1. Pterothorax of first instar nymph. Fig. 2. Pterothorax of fifth instar nymph. *ab1s*, first abdominal spiracle; *bs2-3*, basisternum; *em2-3*, epimeron; *es2-3*, episternum; *f.s.r.*, furcasternal ridge; *ms.*, mesonotum; *ms.f.*, mesosternal furca; *mt.*, metanotum; *mt.f.*, metasternal furca; *op.r2*, opercular ridge; 2-3 *ph.*, phragma; *pl2-3*, pleuron; *pl.r3*, pleural ridge; *pl.*, postnotum; *p.c.a.*, postcoxal apophysis; *pre2*, preepisternum; *pre.r2*, preepisternal ridge; *s.pl.r.*, sternopleural ridge; *sct.s.*, scutellar sulcus; *sl2-3*, sternellum; *th2s*, second thoracic spiracle.

The mesonotum in the adult consists of pretergite, prescutum, scutum and a scutellum, while the metanotum is formed of pretergite, scutum, scutellum and postnotum. The pretergite of the metathorax has been named as the mesopostnotum or postscutellum by Tower,<sup>2</sup> Taylor,<sup>3</sup> Malouf,<sup>4</sup> etc. Certain other workers (Greca and Cesaro<sup>5</sup>) name it mesopostnotum but describe it under the metanotum. The present study indicates that this sclerite is fused with the metanotum and is separated from the mesonotum by a narrow membranous region. In view of this, the sclerite behind the

Each of the pleural walls of the meso- and metathoracic segments also consists of a single plate (*pl2*; *pl3*) in the first nymphal instar and the two segments are confluent with the respective sterna in front and behind the coxal cavity. In the second instar, the *pleural ridge* (*pl. r2*; *pl. r3*) appears in both the segments and demarcates an *episternum* (*es2*; *es3*) from an *epimeron* (*em2*; *em3*). The pleural ridges of both segments are complete in *Dysdercus koenigii* and thus differ from those in another pyrrhocorid, *Pyrrhocoris apterus* and several other heteropterans, where these ridges are

incomplete (Taylor<sup>3</sup>; Greca<sup>8</sup>). The episternum of metathorax is separated from the corresponding sternum by the *sternopleural ridge* (*s.pl.r.*) while the metaepimeron is confluent with the narrow *sternellum* (*sl.*<sub>3</sub>). The *postcoxal apophysis* (*p.c.a.*) appears in the third instar, while the *preepisternal* (*pr.e.r.*<sub>2</sub>) and longitudinal sternal ridges appear in the fourth. However, the *opercular ridges* (*op.r.*<sub>3</sub>) make their appearance in the fifth instar.

The structure of the meso- and metasternum in different nymphal instars is almost similar to that of the adult. It consists of an anterior *basisternum* (*bs.*<sub>2</sub>; *bs.*<sub>3</sub>) and posterior *sternellum* (*sl.*<sub>2</sub>; *sl.*<sub>3</sub>), the two being separated by a *furca-sternal ridge* (*f.s.r.*). In the first stage nymph, both are joined together and there is hardly any trace of an intersegmental membrane. The longitudinal ridges which appear in the second instar gradually approximate together till, in the final moult, they are very close to each other as in the adult.

Thanks are due to Dr. K. N. Saxena for guidance and Prof. B. R. Seshachar for providing working facilities and for suggestions in the preparation of the paper.

Dept. of Zoology,  
University of Delhi,  
Delhi-6, May 1, 1963.

SUDARSHAN KHANNA.

1. Khanna, S., *Curr. Sci.*, 1963, **32**, 216.
2. Tower, D. G., *Ann. Ent. Soc. Amer.*, 1913, **6** (4).
3. Taylor, L. H., *Ibid.*, 1918, **11** (3).
4. Malouf, N. S. R., *Bull. Soc. Roy. Ent. Egypt, Cairo*, 1932, **16**.
5. Greca, M. and Cesaro, R., *Ann. Ist. Mus. Zool. Univ. Napoli*, 1951, **3** (2).
6. Akbar, S. S., *Alig. Muslim Univ. Publ. (Zool. ser.)*, *Indian Insect Types*, 1957, Part 1.
7. Larsén, O., *Lunds. Univ. Arsskrift. N.F. Afd.*, 1945 **b**, **2.41** (11).
8. Greca, M., *Ann. Ist. Mus. Zool. Univ. Napoli*, 1949, **1** (1).
9. Khanna, S., *Indian J. Ent.*, 1963, **25** (1).

#### THE OCCURRENCE OF *PROCERAS POLYCHRYSA* MEYRICK IN RICE STUBBLE AT BAPATLA, ANDHRA PRADESH

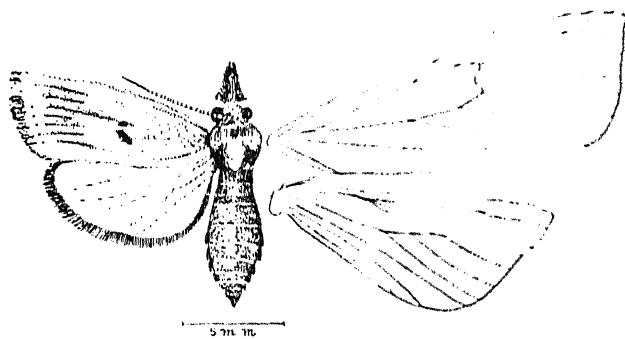
EXAMINATION of samples of rice stubble in the fields around the college campus revealed the presence of the larvæ of the borer, *Proceras polychrysa* Meyr. along with those of *Schoenobius incertulas* Wlk. This had a shiny, dark brown head capsule, a prominent prothoracic shield and the body traversed by reddish-brown linear stripes (Fig. 1). Some of these larvæ

were reared out into adults and these differed from *S. incertulas* in being smaller and in having steel-gray raised spots disposed in the



FIG. 1

form of a crescent in the internomidian space of the forewing (Fig. 2).



*PROCERAS POLYCHRYSA* MEYRICK

FIG. 2

Dissection of the stubbles in one square metre plots at random showed that the population varied from 30% to 85% and hence it is a major pest. The borer was recorded in Kerala by Nair<sup>1,2</sup> and in Andhra Pradesh, this has not been recorded earlier.

Entomology Division, A. PERRAJU.  
Agric. College, A. SATYANARAYANA REDDY.  
Bapatla, Andhra Pradesh,  
India, April 4, 1963.

1. Nair, M. R. G. K., "A rice stem borer, unrecorded in India, *Proceras polychrysa* Meyr. (Pyralidae, Lepidoptera)," *Curr. Sci.*, 1957, **26**, 92.
2. —, "The biology and control of a rice stalk borer, *Proceras polychrysa* Meyrick (Lepidoptera: Pyralidae) from Kerala," *Indian J. Ent.*, 1958, **20**, 136.

ON HELMINTHS RECOVERED FROM  
AN INDIAN HYAENA  
(*HYAENA STRIATA*)

The helminth parasites recorded so far from *Hyæna*, as far as it could be ascertained are: *Tænia hyænae* Baer, 1926 (Baylis,<sup>1</sup> 1937), segments of *Diphyllobothrium* Cobbold, 1858 (Baylis), unidentified tapeworms (Halloran,<sup>2</sup> 1955) and *Dipylidium caninum* (Linné, 1758) (Southwell,<sup>3</sup> 1930) among sesto-da; *Toxocara canis* (Werner, 1782) (Baylis), *Physaloptera brevispiculum* Linstow, 1906 (Yamaguti,<sup>4</sup> 1961), *Diapetolonema dracunculoëdes* (Cobbold, 1870) (Yamaguti), *Dirofilaria sudanensis* (Linstow, 1902) (Yamaguti) from amongst nematodes. The only Indian report relates to *D. caninum* in *Hyæna striata* that had died at Calcutta Zoological Gardens (Southwell).

In the single carcass of *Hyæna striata* available for collection of helminths, the liver was found heavily infested with an opisthorchid fluke while small intestine yielded specimens belonging to *Ancylostoma caninum* (Ercolain, 1859) and to the tapeworm genus *Dipylidium* Leuckart, 1863, for which a systematic determination was not possible as most of rostellar hooks had been lost. As the liver had exhibited gross lesions particularly in its bile ducts the lesioned areas were selected for histological study. A number of specimens were also stained for making permanent mounts. These specimens belonged to *Opisthorchis caninus* (Lewis et Cunningham, 1872) Barker, 1911 (synonym

This finding of *A. caninum* and *O. caninus* in Indian *Hyæna* enlarges the range of the hosts known for these important parasites.

Thanks are due to Dr. B. P. Pande for his guidance and to the Indian Council of Agricultural Research for the award of a Junior Research Fellowship.

Department of Parasitology, J. P. DUBEY.  
U.P. College of Veterinary  
Science and Animal Husbandry,  
Mathura, June 10, 1963.

1. Baylis, H. A., *Ann. Mag. Nat. Hist.*, 1937, Ser. 10, 20, 438 (*Helminth. Abst.*, 6, 117).
2. Halloran, P. O., *J. Amer. Vet. Res.*, 1955, 16, 1.
3. Southwell, T., *The fauna of British India including Ceylon and Burma, Cestoda*, Vol. II, Taylor and Francis, London, 1930, pp. 262.
4. Yamaguti, S., *Systema helminthum*, Vol. II, Parts I & II, Interscience Publishers, New York, 1961, pp. 679 and 1261.
5. Gupta, V. P. and Pande, B. P., *J. Helminth.*, 1963 (in press).

BIOCHEMICAL BASIS FOR THE FOOD  
PREFERENCE OF A PREDATOR  
BEETLE

THE predator beetle *Coccinella septempunctata* L. (Coleop.: Coccinellidæ) feeds on a number of species of aphids but, apparently, it prefers *Lipaphis erysimi* Kalt. over *Aphis gossypii* Glover, and *Macrosiphum granarium* Kirby, as it eats a larger number of these aphids per day and attains higher weight in larval and Cunningham, 1872), Barker, 1911 (synonym

TABLE I  
Chemical and biological analyses of the predator *Coccinella* and its prey

Insect species	Chemical constituents (%)				Biological characteristics of <i>Coccinella</i> *					
	Moisture	Proteins	Fats	Mineral matter	Aphids eaten (per day)	Average weight (m₃.)			Duration (days)	
						Larva	Pupa	Dry pupa	Larva	Pupa
<i>Aphis gossypii</i> ..	52.2	19.2	20.7	6.1	398.9	36.0	32.9	7.8	7.2	3.6
<i>Macrosiphum granarium</i> ..	54.3	18.5	20.0	5.3	365.2	37.9	34.6	8.3	7.2	3.5
<i>Lipaphis erysimi</i> ..	50.0	22.5	21.0	5.5	426.4	39.5	36.4	9.2	7.0	3.4
<i>Coccinella 7-punctata</i> ..	56.4	28.6	7.5	4.9	S.E. ± 7.8	± 1.12	± 0.96	± 0.27	± 0.08	± 0.09

\* Differences were significant at the 5% level.

*Paropisthorchis caninus* Stephans, 1912), wide-spread in the local domestic carnivores and revealed variations in matter of gonads essentially similar to those observed by Gupta and Pande<sup>5</sup> (1963). The pathological changes mainly consisting of a thickening of the bile ducts and marked hyperplasia of the biliary epithelium conformed with those described by them.

revealed that *Lipaphis* contains a higher percentage of protein as compared to the other species and in this respect it is more akin to the beetle.

In order to determine the possible correlation between the biochemical constituents of the prey/predator and the food preference exhibited by the predator, free amino-acids of the four species were qualitatively studied by the

descending technique of paper partition chromatography using Whatman's filter-paper No. 1 stripes (Consden, Gordon and Martin, 1944). Full-grown nymphs of aphids and the adults of *Coccinella septempunctata* were starved for 12 hours in order to clear the alimentary canal. The body tissues of the insects were homogenised and free amino-acids were extracted with alcohol. Phenol saturated with water and *n*-butanol:acetic acid (8:1) saturated with water were used as solvents. After evaporating the solvent at 60°C., the chromatograms were sprayed with 0.14% ninhydrin in *n*-butanol and developed for 5 minutes at 95°C. The spots were identified by comparing their *R<sub>f</sub>* values and also by running mixtures of known amino-acids simultaneously.

The amino-acid constituents of the three species of *Aphis* were: aspartic acid, glutamic acid, threonine,  $\beta$ -alanine, alanine, tyrosine, proline, valine, and leucine. There appeared to be two more unidentified spots which were cited between glutamic acid and threonine with phenol as solvent and between tyrosine and valine with *n*-butanol acetic acid as solvent. In addition to these amino-acids the beetle also contained serine, glycine and an unidentified spot which travelled the least distance both in the phenol and *n*-butanol acetic acid. Since all the three species contained similar free amino-acids it could not be determined by qualitative analysis as to how the predator beetle preferred *Lipaphis*. Perhaps quantitative analysis of the amino-acids would throw some light on the phenomena of specific preference, taking into account that the actual stimulus for the initial attraction would most likely be sensory in nature.

Thanks are due to Dr. G. S. Sidhu, who helped in the identification of the amino-acids.  
Punjab Agric. University, A. S. ARWAL.  
College of Agriculture, S. L. SETHI.  
Ludhiana, March 16, 1962.

1. Consden, R., Gordon, A. H. and Martin, A. J. P., *Biochem. Jour.*, 1944, **38**, 224.

#### INCIDENCE OF *AZOTOBACTER CHROOCOCCUM* IN THE SOILS OF LACCADIVE ISLANDS

*Azotobacter chroococcum* is believed to be very sensitive to the reaction of the medium of its growth. Soils that are neutral or near neutral in reaction, i.e., between a pH range of 6.5 to 7.5 are found to be the most suitable habitat for this strain, and a shifting of the reaction

of the soil to the acid side beyond a pH 5.8 or to the alkaline side beyond a pH 9.0 proves harmful to their existence and under such conditions, *A. chroococcum* could not be detected at all.

But the occurrence of *A. chroococcum* in the soils of Laccadive islands is surprising as the soil pH varies between 8 and 9 and the chemical composition and physical appearance of the soil are entirely different from any other typical soil. Over 80% of the soil is made of  $\text{CaCO}_3$  and the rest calcium phosphate and some soluble salts along with very little organic matter and nitrogen. The analysis of typical Laccadive soil samples from which *A. chroococcum* has been isolated is given in Table I.

TABLE I

		Percentage	
		Sample I	Sample II
Nitrogen	..	0.36	Nil
Phosphoric acid	..	1.31	Trace
Potash	..	Trace	Trace
Calcium oxide	..	46.71	53.2
Magnesium	..	Trace	Trace
Chloride	..	0.09	0.8
Sulphate	..	Trace	Trace
Organic carbon	..	1.11	Trace
pH	..	8.7	8.4
Acid insolubles	..	Nil	Nil

Typical samples of soil were brought from different islands and inoculated into Ashby's liquid mannite media. Invariably in all flasks a black scum developed and covered the entire surface in one week's time.

Microscopic examination of the scum showed the presence of dense and briskly motile bacteria. On solid agar, these bacteria develop into small rounded convex colonies, enlarge in size and turn black in four days time. They were diplococci, very actively motile and gram negative. They formed capsules in aged cultures, but did not produce spores. No acid or slime was produced in culture solution, but they formed a black pigment. Utilised mannite and sugars as energy source and fixed 10 to 12 mg. nitrogen per gram of energy utilised. All these characters are very similar to that of *A. chroococcum*.

Contrary to all the reports that *A. chroococcum* does not grow in acid media, this particular strain has been found to grow well even in media adjusted to pH 4.5. Below this limit the bacterium was found not surviving at all.

Laccadive islands are situated far from the main land and the soil conditions are unlike



those of any typical soil. It is surprising to find how *A. chroococcum* survives under these conditions and that too in high numbers. The composition of the soil, the high number of *A. chroococcum* in the soil and its wide limit of tolerance (pH 9 to 4.5) when taken together opens up new ideas on the physiology of *A. chroococcum*. It is also interesting to note that even though this bacterium has been isolated from highly calcareous soils it is still capable of growing in media devoid of calcium. It appears, therefore, that the limit of tolerance of *A. chroococcum* is not what has actually been believed hitherto but that it could survive under quite abnormal conditions.

Agricultural College and      N. SUBRAMONEY.  
Research Institute,      ALICE ABRAHAM.  
Vellayani, Kerala, April 16, 1963.

### PERFORMANCE OF WHITE DOUBLE TOP CROSS-MAIZE HYBRIDS

In recent years, hybrid maize programme in India has resulted in the release of few double cross-hybrids to the farmers.<sup>1</sup> Still another type of hybrids designated as "Double Top Crosses" (Single Cross  $\times$  Variety) produced by the Ajmer Station of the Co-ordinated Maize Breeding Scheme have also been found to be promising and provide short cut in seed production methods. Data presented by several workers<sup>2</sup> have shown that interaction with environment decreased as the heterogeneity of the material tested increased. A double top cross is comparatively more heterogeneous than a double cross on account of a variety in its

constitution, as such, is expected to provide finer adjustments to the variable growing conditions. Apart from this, it is much easier and quicker to obtain two superior inbred lines which combine well with a variety than to obtain four, required for a double cross. Thus, in a new breeding programme much rapid progress can be achieved by developing a double top cross rather than a double cross in the initial stages.

Wellhausen<sup>3</sup> in Mexico produced two double top crosses, H-305 and H-301 by crossing two top crosses, i.e., (Inbred  $\times$  Variety)  $\times$  (Inbred  $\times$  Variety) which yielded 20% and 8% respectively over the check variety Celeya and were under commercial production during early days of Mexican maize improvement programme. Such type of top crosses may provide wider adaptation, but no short-cut in seed production methods. In production of the proposed double top crosses of the type single cross  $\times$  variety, only five isolations are required and needs maintenance of two inbred lines, one variety and one single cross as compared to seven isolations needed for seed production of a double cross or a cross produced by crossing two top crosses.

For the production of double top crosses, a common white single cross (Eto PL-13-1-#-#-1-#  $\times$  Tenn. 29) was crossed to ten adapted white varieties and were tested at Tabiji Farm, Ajmer, during Kharif 1961 and 1962. During 1962, four crosses were also tested at Vidya Bhawan, Rural Institute, Udaipur. Their yield and moisture percentage data have been tabulated in Table I and Table II, respectively. The

TABLE I  
Performance of white double top cross-hybrids, Ajmer, Kharif 1961 and 1962

Hybrid No.	Pedigree	Grain Yield in Kg./Hectare			Grain Yield % of Basi			Average Moisture % at harvest
		1961	1962	Average	1961	1962	Average	
20	(Eto PL-13-#-#-1-#-1-# $\times$ Tenn. 29)	3940	4638	4189	140	134	134	25.2
37	do. $\times$ Udaipur	3715	4615	4165	132	133	133	27.0
28	do. $\times$ Rocol	3779	4491	4131	134	130	132	26.8
36	do. $\times$ Malan	3940	4221	4080	140	122	130	22.7
35	do. $\times$ K.T. 41	3979	4052	4015	140	117	128	22.8
32	do. $\times$ Indore State	3630	4244	3937	129	123	126	25.0
33	do. $\times$ Maxican June	3585	4289	3937	127	124	126	25.5
30	do. $\times$ Jelicoe	3518	4277	3897	125	124	124	23.0
34	do. $\times$ Rudrapur	3546	4052	3799	126	117	121	22.8
31	do. $\times$ Kalimpong	3163	4204	3633	112	122	118	22.5
	do. $\times$ Pusa Cult. BFL							
Checks :			4192	..	..	122	..	29.2
Hybrid Ranjit		2814	3450	3132	100	..	100	21.4
Basi Variety								
L.S.D. at 5% =			705.0	714.0				

Hybrid No.	pedigree	Grain yield kg./Hectre	Yield % of Basi	Moisture % at harvest
28	(Eto P1-13- $\frac{1}{2}$ - $\frac{1}{2}$ - 1- $\frac{1}{2}$ x 'Tenn. 29) x Mahan	8950	150	30.2
30	do. x Rudrapur	8206	137	28.4
29	do. x Udaipur	8105	136	27.4
35	do. x Indore	8018	135	27.6
Checks :				
	Hybrid Ranjit	7684	129	32.6
	Easi Variety	5952	100	21.9
L.S.D. at 5% =		1109.0		

Recently, a comprehensive and comparative study of the development of the endosperm in 18 species distributed in 11 genera of Euphorbiaceae enumerated in Table I has been made by us and in all these also a Nuclear type of development has been found.

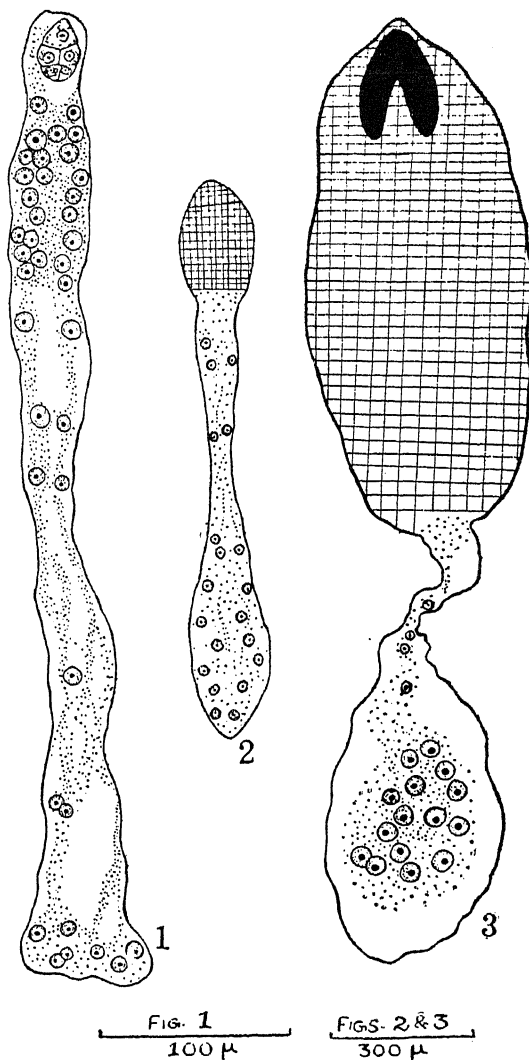
TABLE I

Tribe	Species investigated
Phyllanthæ	.. <i>Phyllanthus simplex</i> Retz., <i>P. debilis</i> Herb. Ham., <i>P. maderaspatensis</i> Linn., <i>Saurofus quadrangularis</i> Muell., <i>Neopellandra suberosa</i> Thw.
Crotonæ	.. <i>Croton sparsiflorus</i> Morong., <i>C. klotzschianus</i> Gamble.
Acalyphæ	.. <i>Acalypha alnifolia</i> Klein ex Willd., <i>A. paniculata</i> Miq., <i>A. malabarica</i> Muell. Arg., <i>Trasia camalina</i> Linn., <i>T. involucreta</i> Linn., <i>Micrococca mercurialis</i> Benth.
Gelonieæ	.. <i>Boiospermum montanum</i> Muell. Arg.
Hippomenæ	.. <i>Sebastiania chamelea</i> Muell., <i>Excacaria agalocha</i> Linn.
Euphorbieæ	.. <i>Euphorbia oricophila</i> Miq., <i>E. geniculata</i> Orteg.

Among the species investigated by us, the primary endosperm nucleus is 8-9-ploid in *A. alnifolia*, 5-ploid in *A. paniculata* and *A. malabarica* and 3-ploid in the rest. The division of the primary endosperm nucleus precedes that of the fertilized egg. The endosperm becomes completely cellular in the older stages of development. However, two species of the genus *Croton*: *C. sparsiflorus* and *C. klotzschianus* form an exception in one important respect, namely, in the formation of a free nuclear chalazal haustorium, a feature not so far reported in any other Euphorbiaceæ known to us.

In the two species of *Croton* mentioned above the embryo-sac is situated in the upper part of the nucellus. It shows a slight protrusion towards the chalazal end at the time when 4-8 endosperm nuclei are formed. The protrusion gradually becomes elongated towards the chalazal end of the ovule. Meanwhile, repeated free nuclear divisions take place in the endosperm nuclei which become distributed in the embryo-sac peripherally. Greater accumulation of cytoplasm and nuclei takes place in the micropylar region in the free nuclear stage (Fig. 1). Cell-wall formation sets in only in the micropylar region, while the endosperm in the chalazal region remains free nuclear throughout (Fig. 2). This region gradually assumes the shape of a narrow tubular cæcum which broadens conspicuously in its chalazal portion (Fig. 3). The narrower part of the cæcum contains a thin layer of cytoplasm with few nuclei while numerous nuclei accumulate in the broad chalazal part. This cæcum behave as an aggressive chalazal haustorium gradually bringing about a dissolution of the surrounding tissue of the nucellus. The maximum length attained by the haustorium is

about 1,000  $\mu$ . The clear detection of the haustorium in these two species has been possible by study of whole mounts of endosperm prepared by dissection of fresh material to



FIGS. 1-3. Fig. 1. An embryo-sac of *C. sparsiflorus* showing greater accumulation of cytoplasm and endosperm nuclei in the micropylar part. Fig. 2. Whole mount of the endosperm of *C. klotzschianus* showing cellular micropylar part and free nuclear chalazal cæcum. Fig. 3. Whole mount of the endosperm of *C. sparsiflorus* at an older stage showing chalazal haustorium broadening towards the base.

supplement the observations made on serial microtome sections of the ovule. Thathachar<sup>5</sup> previously studied the embryology of *Croton sparsiflorus* but did not report on the occurrence of the endosperm haustorium. In our

studies it has been made out invariably in all of the numerous ovules examined. The haustoria reported here in the two species of *Croton* closely resemble those recorded in Proteaceae, Leguminosae, and Cucurbitaceae.

Our thanks are due to Mr. G. Rajeswara Rao, Department of Botany, Sri Venkateswara University, Tirupati, for kindly fixing material of *C. klotzschianus* from Tirupati at our request and to Mr. B. S. M. Dutt for providing us with the material of *Excoecaria agallocha* fixed by him at Kakinada. One of us (P. N. R.) is grateful to the Government of India for a scholarship during the tenure of which the work has been done.

Dept. of Botany, J. VENKATESWARLU.  
Andhra University, PIRATLA NARASIMHA RAO.  
Waltair, June 28, 1963.

1. Schnarf, K., *Vergleichende Embryologie der Angiospermen*, Berlin, 1931.
2. Wunderlich, R., "Zur Frage der Phylogenie der Endospermytypen bei den Angiospermen," *Osterr. Bot.*, 1959, **106**, 233.
3. Kapil, R. N., "Embryology of *Acalypha* Linn.," *Phytomorphology*, 1960, **10** (2), 174.
4. Mukherjee, P. K., "Embryology of two Euphorbiaceae," *Proc. Ind. Acad. Sci.*, 1961, **23 B**, 217.
5. Thathachar, T., "Morphological studies in the Euphorbiaceae," *Jour. Mysore University*, 1953, **13**, Part VII, 43.

#### OCCURRENCE OF A TYROSINASE INHIBITOR IN THE HAEMOLYMPH OF *GALLERIA MELLONELLA* L. INFECTED BY *MATTESIA DISPORA* NAV.

BLACKENING of haemolymph through the oxidation of tyrosinase has been one of the characteristic preceding expressions of many insect diseases. This ready oxidation of tyrosinase to toxic quinones has also hampered studies on the insect blood besides prohibiting its use in the culture of insect tissues.<sup>1</sup> Various workers have adopted different means for checking this reaction but the methods tried involving (i) destruction of insect blood tyrosinase by heat,<sup>2</sup> (ii) use of chemicals like phenylthiourea, p-aminobenzoic acid, ascorbic acid, glutathione and disodium ethylene diamine tetraacetate,<sup>3</sup> did not give any permanent inhibition.

During studies on the culture of tissues from the last larval instar of *Galleria mellonella* L. infected with *Mattesia dispora* Nav., a schizogregarine (presence in the haemolymph of free sporozoites as a result of the artificial inoculation with spores about 16 days before), an

interesting phenomenon was observed, viz., that the haemolymph from *G. mellonella* infected with *M. dispora* did not blacken at all. In fact, the material could be kept under any condition for indefinite period without any blackening. This led the author to surmise that either tyrosinase was not synthesised in the *Galleria* larvæ infected with *M. dispora* or some inhibitor which could block the tyrosinase activity was formed in the insect. However, the observation that the addition of the haemolymph in various ratios 1:1, 2:1, 3:1, 4:1 to the haemolymph derived from the healthy *Galleria* larvæ could effectively prevent the blackening of the latter clearly showed that the haemolymph of *Galleria mellonella* infected with *Mattesia dispora* contained a tyrosinase inhibitor.

Further studies on the nature and identification of this inhibitor are in progress.

Institute of Biology, K. SEN GUPTA.\*  
Czechoslovak Acad. of Sci.,  
Prague, April 8, 1963.

\*Present address: Section of Pathology, Central Sericultural Research Station, Berhampore, West Bengal.

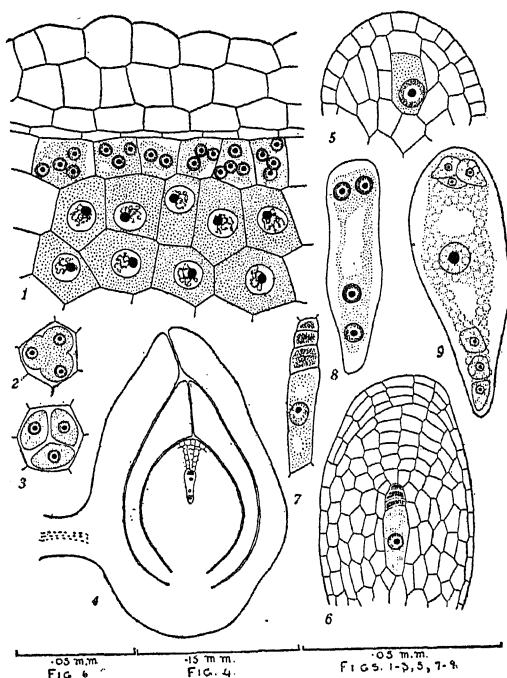
1. Sen Gupta, K., *Fol. Biol.*, 1961, **7**, 400.
2. Levenbook, L., *Biochem. Jour.*, 1950, **47**, 336.
3. Wyatt, S. S., *J. Gen. Physiol.*, 1956, **39**, 841.

#### A NOTE ON THE EMBRYOLOGY OF A FEW RUTACEAE

THE earlier embryological work in the family Rutaceae was summarized by Schnarf (1931). Since then only a few important papers have appeared on the embryology of the family (Mauritzon, 1935; Johri and Ahuja, 1957; Desai, 1963). The present paper deals with the embryology of *Chloroxylon swietenia* DC., *Feronia elephantum* Corcea and *Glocosmis pentaphylla* Correa.

The fully differentiated anther shows an epidermis and 3-5 wall layers (Fig. 1). The cells of the hypodermal wall layer develop fibrous thickenings and function as the endothecium in the mature anther. The innermost wall layer functions as the tapetum of the secretory type, the cells of which become multinucleate by the time the microspore mother cells begin to undergo meiosis (Fig. 1). The middle layers become crushed during the development of the anther. Cytokinesis takes place by furrowing (Fig. 2). Pollen tetrads are tetrahedral (Fig. 3). The pollen grains are 3-colporate in *Chloroxylon* and *Glycosmis* and

3-6-colporate in *Feronia* and are 2-celled in the shedding stage.



FIGS. 1-9. Figs. 1-3, 5, 6. *Chloroxylon swietenia*. Fig. 4. *Feronia elephantum*. Figs. 7-9. *Glycosmis pentaphylla*. Fig. 1. L.S. part of anther lobe showing microspore mother cells and tapetum. Fig. 2. PMC showing cytokinesis. Fig. 3. Pollen tetrad. Fig. 4. L.S. ovule. Fig. 5. L.S. ovule showing the archesporial cell that has cut off a primary parietal cell. Fig. 6. L.S. nucellus showing parietal tissue and nucellar cap; note megaspore tetrad with enlarging chalazal megaspore. Fig. 7. Linear megaspore tetrad with functional chalazal megaspore. Fig. 8. 4-nucleate embryo-sac. Fig. 9. Organized embryo-sac.

The ovule is crassinucellate, bitegmic and anatropous in *Chloroxylon* and *Glycosmis* and hemianatropous in *Feronia* (Fig. 4). The micropyle is formed by both the integuments (Fig. 4). The parietal tissue is 5-7-layered (Figs. 4, 6). A nucellar cap of 3-5 layers is present in *Chloroxylon* and *Glycosmis*, while no such cap formation was observed in *Feronia* (Figs. 4, 6).

The archesporium in the ovule is single-celled and hypodermal (Fig. 5). A multicellular archesporium was also observed. The archesporial cell functions as the megaspore mother cell after cutting off a primary parietal cell (Fig. 5), which gives rise to a parietal tissue of 5-7 layers (Fig. 6). The chalazal megaspore of the linear megaspore tetrad is functional and the embryo-sac development follows the Poly-

gonum type (Figs. 6-9). The embryo-sac shows the usual organization and is packed with starch grains in *Glycosmis* (Fig. 9).

According to Desai (1963), the embryo-sac development in *Glycosmis* follows the 'Onagrad' type. The present study shows the embryo-sac development in *Glycosmis* follows the Polygonum type as in *Chloroxylon* and *Feronia* and other investigated genera of the family.

I wish to thank Prof. M. R. Suxena for his kind interest and Mr. P. S. Prakasa Rao for the material of *Glycosmis*.

Department of Botany, L. L. NARAYANA.  
Osmania University,  
Hyderabad-7 (A.P.), March 27, 1963.

1. Desai, Sharda, *Phytomorphology*, 1963, 12, 178.
2. Johri, B. M. and Ahuja M. R., *Ibid.*, 1957, 7, 10.
3. Mauritzon, J., *Svensk. bot. Tidskr.*, 1935, 29, 319.
4. Schnarf, K., *Vergleichende Embryologie der Angiospermen*, Berlin, 1931.

# OCCURRENCE OF *CURVULARIA* *SPICIFERA* (BAINIER) BOEDIJN : *HELMINTHOSPORIUM SPICIFERUM* (BAINIER) NICOT ON *CELOSIA* *CRISTATA* L.

In the course of investigations of the 'Fungi causing plant diseases at Muzaffarpur' the authors encountered a leafspot disease of *Celosia cristata* L. caused by *Curvularia specifera* (Bainier) Boedijn: *Helminthosporium speciferum* (Bainier) Nicot.

The disease was observed on the leaves of *Celosia cristata* L. in the Botanical Garden of L.S. College, Muzaffarpur, in the months of February and March, 1961, 1962, and also during the same months of the present year.

**Pathogenicity.**—The pathogenicity of the organism was established by isolating it from the infected leaves of the host and by reinoculating the same on the latter. It was observed that the artificial inoculations produced symptoms of the disease similar to those found in nature.

**Symptoms.**—The disease is characterised by the appearance of oval, interveinal foliar spots which are mostly seen on the older leaves of the plant. The spots are mostly isolated and not coalescent. The lesions which are tan to dark brown in colour are present on both the surfaces of the leaf. There are brown concentric rings on each spot. Later the patches enlarge and become irregular in shape.

**Organism.**—The conidiophores are brown, simple, unbranched, septate with geniculate markings at the tips, erect, straight or bent at

the apex and measure  $2.6-5.2\mu$  in width. The length of the conidiophores is much variable. The conidia are borne at the tips of the conidiophores. They are brown, ellipsoidal, mostly straight and seldom curved. The number of septa in the conidia is usually 3 but 5-6-septate condition is also met with though rarely. The middle cells are the broadest and darkest, while the upper and lower cells are paler and narrower. The conidia measure  $18.2-44.2\mu \times 7.8-10.4\mu$ . The average size of the conidia is  $26.57\mu \times 8.14\mu$ .

As far as is known to the authors *Curvularia specifera* (Bainier) Boedijn has not been recorded in India on any host. The specimen has been deposited in the herbaria of the Commonwealth Mycological Institute, Kew, England (No. 92926).

The authors express their gratitude to Dr. J. C. F. Hopkins, Director, and Dr. Ellis of the Commonwealth Mycological Institute, Kew, England, for identifying the pathogen.

Department of Botany, S. S. PRASAD  
Bihar University, B. D. SINHA.  
Muzaffarpur, April 8, 1963.

**EXOSPORIUM AMPULLACEUM**  
(PETCH) M. B. ELLIS = (*HELMINTHOSPORIUM AMPULLACEUM* PETCH),  
A NEW RECORD FOR INDIA

THE fungus forms black pulvinate colonies composed of closely aggregated conidiophores on the substratum, viz., dead wood of *Vallisneria spiralis* Spreng, collected from the Botanical Garden, Motilal Vigyan Mahavidyalaya, Bhopal, on 11th October 1962. The conidiophores arise from a dark brown stromatic tissue that is composed of brownish-black, branched septate hyphae which are up to  $4\mu$  thick. The conidiophores are dark brown to yellow brown, simple, erect, straight or bent, cylindrical, septate, up to  $360\mu^*$  long, with pulvinate spore attachments towards apex.

The conidia are produced acrogenously and singly at the tips of conidiophores. They are obclavate, broad at base and tapering towards apex, up to 21 (mostly 9-13) septate, yellow brown becoming paler towards apex, thick-walled, basal 5-6 cells distinctly verrucose,  $88-250\mu$  long (mostly  $110-154\mu^*$ ),  $17.6-22\mu^*$  where they are broadest.

Apex clothed with a translucent mass about  $3\mu$  thick for a length of about  $20\mu$ .

Base of the conidia and apex of conidiophores strongly thickened and opaque. The basal cell

of the conidia becomes gradually hyaline in glycerine. The type specimen has been deposited in the herbarium of the Commonwealth Mycological Institute, Kew, IMI. No. 96460.

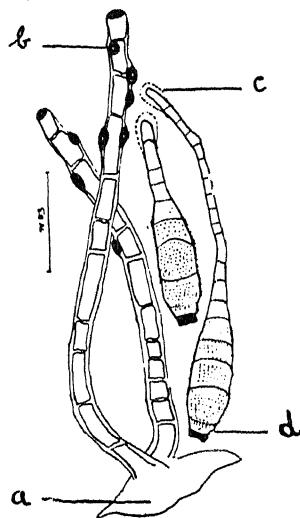


FIG. 1. (a) Stromatic tissue. (b) Pulvinate spore attachment. (c) Apex of conidia clothed with translucent mass. (d) Basal cell of conidia with base strongly thickened and opaque.

The author expresses his grateful thanks to Prof. O. N. Handoo, Department of Botany, Motilal Vigyan Mahavidyalaya, Bhopal, for facilities and encouragement.

Thanks are also due to the Director and Dr. Ellis, of Commonwealth Mycological Institute, Kew, for the help in identification of the species.

Dépt. of Botany,  
M.V. Mahavidyalaya,  
Bhopal, April 27, 1963.

H. N. SATYA.

1. Petch, *Ann. Roy. Bot. Gardens, Paradise, 1922*, 7 (4), 319.

\* Original measurements by Petch. Conidiophore— $500\mu$ . Conidia— $80-116 \times 22-26\mu$ . Septa—6-9.

**A NEW HANSFORDIELLA FROM INDIA**

THE organism which forms the subject of this communication was collected by the authors from Mallar (South Kanara), India, infecting the leaves of *Pavetta indica* L. The infection spots are initially black, circular consisting of black, cottony, conglomerate mycelium. Later, the mycelium becomes spread irregularly on the surface of the leaves, then resembling a sooty mould externally. The infection spots

are epi- and hypo-phyllous. The creeping mycelium is branched, septate, subhyaline to light brown,  $3-5\mu$  wide, producing conidiophores from a swollen basal cell or not. The conidiophores are bent or erect, unbranched, subhyaline to light black at the base, becoming blackish-brown at their fertile apices, geniculate,  $78-328\mu$  long,  $7-11.5\mu$  wide, 6-26-septate and consisting of many circular scars or cup-like pouches in the fertile apical region measuring  $54-118\mu$  in length. Each scar is round to oval, slightly elevated, measuring  $1.5-3.6\mu$  in diameter, indicating points of attachment of conidia. The conidia are blackish-brown to deep brown, 1-6-septate,  $25.2-72.5\mu$  long,  $7-11\mu$  broad, obclavate to elongate, acrogenous and single. The basal cell of each conidium has a scar showing its attachment to the conidiophore and is characteristically crucible-shaped, while the apical cell is narrow and is slightly elongate. The conidial wall is thick and, significantly, notched at the septa thus giving jointed appearance.

The above-described fungus is a *Hansfordiella* (Hughes). It differs from all the species<sup>1,2</sup> in conidiophore, conidial measurements, septation and attenuated conidial walls. As such, it is described as a new species.

*indica* L., "Herb. Hyderabadense" V.V.C.B.L. No. 104.

Obviously, this is not only the first collection of this fungus from India but also an addition to the five species of *Hansfordiella* known so far.

*Hansfordiella indica* RAGHUVeer AND DEV RAO  
Sp. Nov.

Infectionis maculae diametientes 2-4 mm., macular irregulares latieres, mycelium superficialia, aggregatum irregulari latieres, carbonaceas. Hyphae repentes, subhyalinae vel pallide brunneae, ramosae, septatae,  $3-5\mu$  latae. Conidiophori occurantis, in massis, compactis et divergentibus, simplices, erecti vel incurvi, cylindrici, subhyalina vel pallide carbonaceas ad basin, fuliginous ad apicem, geniculati  $78-328\mu$  longi,  $7-11.5\mu$  lati, 6-26 septati, ad apices fertiles supra,  $54-118\mu$  longi, producti cicatrice cyathiformis, cicatrice interno vel externus,  $1.5-3.6$  diam. Conidia producta, acrogena, singula ab cicatrice cyathiformis, obclavata vel elongata, 1-6 septata,  $25.2-72.5\mu$  longa,  $7-11\mu$  lata ad basin,  $3-5\mu$  lata ad apicem, constricta ad septa.

Typus lectus infoliis viventibus *Pavetta indica* L. in loco Mallar, in provincia Mysore, die 2, mensis Aprilis, anni 1963, a. P. R. R. et positus in herbario hyderabadense V.V.C.B.L. sub numero 104.

The authors are highly obliged to Prof. M. R. Suxena, Osmania University and Dr. S. D. Satwalekar, Principal, V.V. College, for providing facilities and encouragement.

Nizam College, P. RAGHUVeer RAO.  
Vivek Vardhini College, DEV RAO.  
Hyderabad A.P.,  
April 24, 1963.

1. Hughes, S. J., *Mycol. Pap.*, 1951, 47, 10.
2. Subramanian, C. V., *Proc. Ind. Acad. Sci.*, 1957, 45 B, 282.

# EFFECT OF COPPER NUTRITION ON MULTIPLICATION AND CONCENTRATION OF SUNNHEMP MOSAIC VIRUS

EARLIER experiments by different workers indicated that iron,<sup>1</sup> manganese,<sup>2</sup> zinc,<sup>3</sup> boron<sup>4</sup> and molybdenum<sup>5</sup> play an important role on the growth of the host plants as also on multiplication and concentration of the inoculant viruses. This paper presents the results of experiments on the effect of copper nutrition on multiplication and concentration of sunn-hemp mosaic virus.<sup>6</sup>

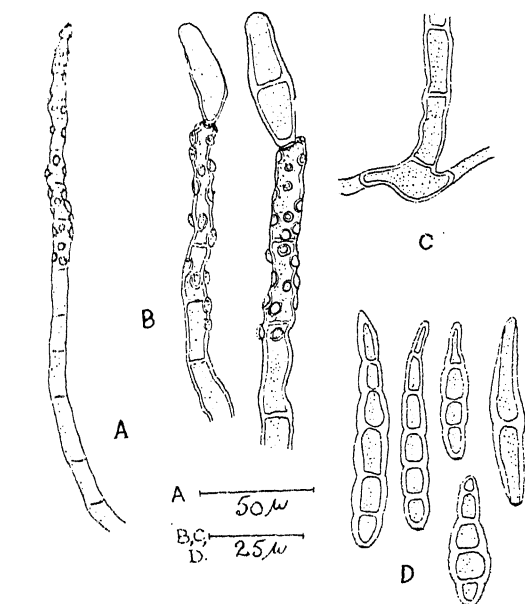


FIG. 1. A, Conidiophore entire; B, Conidiophores with conidia; C, Swollen basal cell of the conidiophore; D, Conidia.

Collected by Raghuvier Rao from Mallar on 2-4-1963 infecting the leaves of *Pavetta*

The method followed for raising the sunnhemp (*Crotalaria juncea* L.) plants for the studies and the nutrient solution used was the same as described earlier,<sup>5</sup> except for the different levels of copper such as 0.00, 0.01, 0.02, 0.04 and 0.08 p.p.m. in the form of copper sulphate. Half the number of seedlings were inoculated with sunnhemp mosaic virus under each treatment keeping the other half as uninoculated controls. The height, fresh weight, and leaf area of eight inoculated and eight non-inoculated plants were recorded at 5, 10, and 15-day intervals following inoculation. The procedure followed for the preparation of the inoculum and the method of inoculation employed to study the concentration of the virus is the same as already described.<sup>7</sup> Each sample of inoculum obtained from the plants under different treatments were inoculated on the leaves of guar [*Cyamopsis tetragonoloba* (L.) Taub.] plants till the inoculum exhausted. The total number of lesions produced under each treatment was recorded.

It was observed that increase in supply of copper increases the growth of the sunnhemp plants up to 0.02 p.p.m. beyond which (0.04 and 0.08 p.p.m.) the growth was retarded. Plants receiving no copper exhibited a general stunted growth, yellowing, commonly followed with drying of the young leaves from top to downwards in a die-back pattern, typical of copper deficiency. Plants growing at 0.04 and 0.08 p.p.m. levels of copper were also stunted and the leaves showed irregularly distributed necrotic patches, marginal drying, finally resulting in premature dropping of the leaves.

From the results (Fig. 1) it is clear that the number of local lesions progressively increased with the increased supply of copper up to 0.02 p.p.m. and decreased at 0.04 and 0.08 p.p.m. However, it is clear that a copper concentration 0.02 p.p.m. which allows maximum growth of the host (sunn hemp) also favours maximum virus concentration. Both growth and virus concentration fall rapidly beyond 0.02 p.p.m. of copper, thus indicating a direct correlation between the growth of the plants and the concentration of the virus.

The author wishes to express his gratitude to Dr. R. S. Vasudeva for his keen interest and

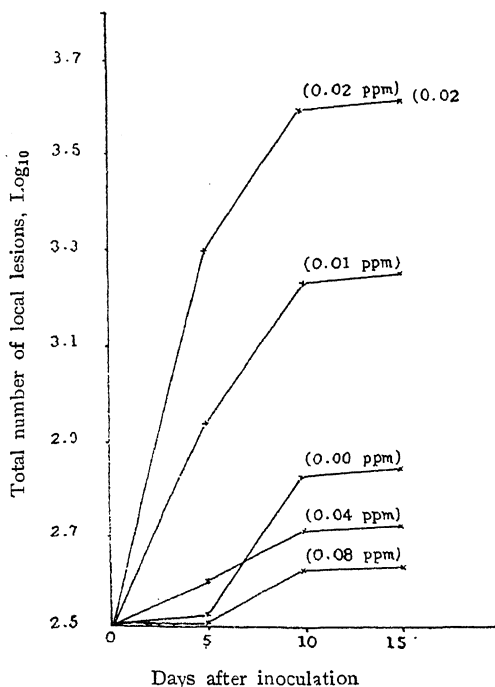


FIG. 1. Different levels of copper nutrition in relation to multiplication and concentration of sunnhemp mosaic virus.

to the Council of Scientific and Industrial Research, India, for the financial assistance.

Division of Mycology and Plant Pathology,  
Indian Agric. Res. Institute,  
New Delhi, May 6, 1963.

K. S. M. SASTRY.

1. Pound, G. S. and Welkie, G., *Virology*, 1958, 5, 371.
2. Welkie, G. and Pound, G. S., *Ibid.*, 1958, 6, 540.
3. Helms, K. and Pound, G. S., *Ibid.*, 1955, 1, 408.
4. Shepherd, R. J. and Pound, G. S., *Phytopathology*, 1960, 50, 195.
5. Sastry, K. S. M., *Curr. Sci.*, 1962, 31, 347.
6. Raychaudhuri, S. P., Nariani, T. K. and Das, C. R., *Indian Phytopath.*, 1962, 15, 79.
7. Sastry, K. S. M. and Vasudeva, R. S., *Indian J. Agric. Sci.*, 1963, 33, 118.



## REVIEWS

**Complex Numbers and Functions.** By T. Estermann. (Asia Publishing House, Calicut Street, Bombay-1), 1962. Pp. viii + 250. Price Rs. 14-00.

This book is an elementary introduction to the Theory of a Function of a complex variable. It deals with the usual topics but the author aims at perfect rigour. Whether this made it necessary, as he thinks, to avoid any appeal to geometric intuition may be debatable. Beginners may find it useful and there is no harm in calling it into play provided one lays stress on its dangers. The treatment of the author is no doubt rigorous but it might have been more systematic, had he insisted a little more on the topological foundations of the theory. This makes it possible to introduce the notion of limit in a manner which is at the same time simpler and more general. Although the author has restricted himself to the elementary aspect of the theory, he has included two topics which may invite the students to acquire a deeper knowledge of it. I mean the questions connected with the notion of Jordan curve and the Picard's theorem. The book will certainly prove very profitable to students as well as to teachers.

C. RACINE.

**Advanced Materials—Refractory Fibres, Fibrous Metals, Composites.** By C. Z. Carroll-Porczynski. (Asia Publishing House, Bombay-1), Pp. 286. Price Rs. 32-00.

The book under review is an excellent collated comprehensive account under one cover of all the progress made in the challenging field of new and potentially important materials to meet the ever-increasing demands in the space age for higher and higher operating speeds and temperatures. The accent specifically has been on refractory fibres, fibrous metals and composites, materials which are relatively new, some of only just academic interest while others have hardly crossed the threshold of pilot plant development and evaluation. It needs hardly to be emphasised that the revolutionary materials primarily developed for the aerospace applications are also bound to interest many a new and developing industry.

This eleven-chaptered book starts off by stating the high temperature problem in general

and predicts the use of reinforced plastics and heat insulating materials in such varied applications like rockets and missiles, nuclear reactors and supersonic jets.

The properties, preparation and uses of fused silica fibres and the high silica content fibres both singly and in combination with resins and ceramics are described in some detail in Chapters 2 and 3. Next follows the chapter on the high temperature resistant and light weight aluminium silicate fibres of special significance as insulation material in jet engines. Potassium titanate fibres, a du pont development, finds a detailed treatment in Chapter 5 and this is followed by a review of the progress made in the development of some of the super-refractory fibres like oxide fibres, whiskers and carbon and graphite fibres of significance to the aerospace materials engineers in view of their amazing strength-to-weight ratios, and ablation properties.

The role and application of asbestos in high temperature resisting composite materials, in aircrafts-rockets and missiles with their unique ablative properties are discussed in detail in Chapters 7 and 8 with a large number of micrographs and illustrations. The development of metal wools, metal fibre paper, reinforced ceramics and woven and knitted wire filaments and their varied uses in a variety of industries is described excellently with a number of drawings in Chapter 9, and this is followed by a short chapter on some coated fibres like metal-coated glass and metal-coated refractory fibres of use in jet aircrafts and others. And in the last chapter is described some miscellaneous fibres like those of the titanium dioxide and boron.

The author rightly hopes that this book will fill a much-needed gap in the available literature on this new and challenging field of New Materials. The book in its present form with a large number of tables, graphs, micrographs and illustrations and numerous references is a welcome work of reference to the student and serious researcher in the fascinating field of Advanced Materials.

A. A. KRISHNAN.

**The Bacteria—A Treatise on Structure and Function.** Edited by I. C. Gunsalus and R. Y. Stanier. Vol. IV: The Physiology of Growth. (Academic Press, New York and London), 1962. Pp. xiv + 459. Price \$16.00; (Subscription Price \$14.50).

This volume, IV in the series on the Bacteria, contains nine reviews covering a wide range of subjects in microbial physiology such as synchronous growth, nutritional requirements of micro-organisms, ecology of bacteria, exoenzymes, permeation, physiology of sporulation, temperature relationships, halophilism and antimicrobial agents. As stated in their preface, the editors have rightly excluded other topics considered by them as those which come under the subtitles of other volumes in the series.

The authors contributing to this book are to be congratulated in packing a considerable amount of valuable information into a small space as exemplified by the chapters on the nutritional requirements of micro-organisms and the physiology of sporulation. All the chapters in the volume are authoritative as well as comprehensive and provide an up-to-date knowledge of the topics dealt with. The book is well printed and remarkably free from errors. It will prove to be a most valuable addition to all the libraries and is recommended to specialists as well as students of the subject.

J. V. B.

#### **Advances in Insect Physiology (Vol. I).**

Edited by J. W. L. Beament, J. E. Treherne and V. B. Wigglesworth. (Academic Press, London and New York), 1963. Pp. xiii + 512. Price 105 sh.

In recent years insects have become a particularly fertile subject for investigation not merely for the physiology of the insect themselves but also for all aspects of animal physiology such as the chemistry of natural products, the dynamic biochemistry of intermediary metabolism, the physical structure and biophysics of cells, electrophysiology of nerve and muscle, ionic and osmotic regulation, physiological genetics and developmental mechanics, the function of hormones, neurohormones and pheromones, the mechanism of sensory perception, the physiology of animal behaviour, etc. A vast amount of work is being done in all these fields with insect as the experimental material. A flood of papers from all over the world is the result. It is obvious that periodical reviews of work in this rapidly

growing field are necessary to enable us to keep abreast of recent developments. The present one is the first of a series of such reviews projected by the publishers.

The present volume contains reviews on seven topics as follows: In the first chapter E. H. Colhoun discusses the role of acetylcholine (a substance well known in the nervous physiology of mammals) in insect nervous physiology. The occurrence of acetylcholine (the cholinergic system) has been demonstrated in a large number of insects belonging to several orders such as Orthoptera, Hemiptera, Lepidoptera, Coleoptera, Hymenoptera and Diptera. It appears that acetylcholine has function in the nervous system but not in synaptic transmission at neuromuscular junctions. It is released on stimulation of preganglionic fibres, the results being detected in the presence of eserine. Acetylcholine also occurs in insect tissues of non-neural origin.

In the second chapter R. H. Dadd discusses such aspects of food behaviour of grasshoppers and locusts as the food-plant preferences, attraction and orientation to food-plants and phagostimulation. He also discusses nutritional aspects such as the requirements of protein, amino-acids, carbohydrates, lipids, minerals and vitamins.

In the third chapter B. A. Kilby discusses the biochemistry of insect fat with special regard to carbohydrate, protein and amino-acid metabolism, purines, etc., and tissue respiration.

In the fourth chapter T. Narahashi discusses the properties of insect axons such as the membrane potential and electrical excitability, ionic composition of hemolymph and nerve activity, ionic fluxes and metabolism, etc.

In the fifth chapter K. M. Rudall reviews the work on chitin/protein complexes of insect cuticles based on chemical and X-ray analyses as well as electron microscopy.

In the sixth chapter J. Shaw and R. H. Stobbs review work on osmotic and ionic regulation in aquatic and terrestrial insects in considerable detail, as well as the overall regulation of soil and water balance in insects.

In the seventh chapter D. S. Smith and J. E. Treherne deal with functional aspects of the nervous system. The structure and function of such organs as the nerve sheath, the neural lamella, the perineurium, the glial cells, the neurone, the Golgi bodies of the neurone and the extracellular systems are discussed and illustrated in considerable detail.

An examination of the bibliographies given at the end of each section shows that Indian contribution is very limited. It is to be hoped that more Indian workers will take to this field of insect physiology. There is an author index and a useful subject index.

The book is beautifully printed and produced and is attractively bound. We would like to congratulate both the publishers and the editors on bringing out this extremely useful volume, and shall look forward to the subsequent volumes.

M. L. ROONWAL.

---

**Thin Film Chromatography.** By E. V. Truter. (Cleaver-Hume Press, Ltd., London), 1963. Pp. xi + 205. Price 37 sh. 6 d.

It does not require uncanny prescience to predict that before long thin layer chromatography will be a routine tool in organic and biochemical laboratories. It is simple, versatile and fast. There is no known separation technique which equals it in resolving power.

In this excellent book the author has succeeded in presenting a balanced and adequate survey of the important aspects of TLC. The three parts into which the book is divided deal with principles, operational details and applications. A comprehensive bibliography of 282 references covers literature up to 'late' 1962.

The book is warmly recommended for research workers and analytical chemists interested in keeping in step with progress.

M. V. BHATT.

---

**Molecular Genetics, Part I.** Edited by J. Herbert Taylor. (Academic Press, Inc., New York and London), 1963. Pp. xii + 544. Price \$ 14.50.

The problem of heredity has interested students of many disciplines and for over a decade now attempts have been made to study it at the molecular level. The recent advances in *Molecular Genetics* were highlighted by the award of five Nobel Prizes last year to pioneers in this field. A corollary to any rapid advance in a discipline is the difficulty in following the rapid changes in concepts. This is more true when ideas have yet to crystallize.

Since DNA is now presumed to be the carrier of heredity, the reader is introduced to its organization in chromosomes, its replication and its mutability. The genetic information carried by DNA has to be transferred to the cytoplasm and then translated in order to find expression.

RNA being the middleman, there are chapters dealing with its biosynthesis and its role in transfer and translation of information.

It is stated: "In a field which moves as fast as molecular genetics, publications tend to be outdated before they are off the press. To circumvent this, in part at least, we have covered some material of lasting importance, presented the newest developments known to us while writing, and in some cases looked into the future with a bit of speculation that will hopefully prove stimulating and productive."

The volume thus is an attractive introduction to an exciting new field.

M. K. S.

---

**The Clavariaceae of India.** By K. S. Thind. (The Indian Council of Agricultural Research, New Delhi), 1961. Pp. 197. Price Rs. 20.00.

This monograph on Indian Clavariaceae is the second in the series on fungi being published by the Indian Council of Agricultural Research and is to be welcomed as an addition to the literature on Indian fungi. The author and his colleagues have been engaged in the serious study of this group for some years and the bulk of the Indian records of the Clavariaceae comes from their arduous collecting and painstaking study of specimens whose gross features are well brought out in suitable illustrations and photographs. Identification of these fungi is not easy and the author has received generous help in this from Mr. Corner himself whose monograph on the Clavariaceae is well known. The materials for a preliminary account of the Clavariaceae of India have thus become available and this monograph deals with 92 taxa belonging to 15 genera: what the author calls "Clavarias" (Clavariaceae would have been a more precise appellation!).

The systematic account (pp. 26-180) follows a general Introduction, the substance of which is largely derived from Corner's work which has rightly served as a source of inspiration for the author. Much of what is presented in the Introduction and the Systematic account can be found in Corner's book except, of course, the simplified Key to the genera recorded from India and information on taxa recorded or newly described from India. All the same, the introductory part provides the reader with a clear account of the general features of the group.

It is perhaps too much to expect anything novel in the approach to the taxonomy of the Clavariaceae in a work like this; for, only

recently has the group been thoroughly treated by Corner and novelties would have required a deeper and intensive study of the group as a whole. There is no doubt that the appearance of Corner's work has simplified the difficulties of the author and, indeed, of other students of this group elsewhere. The value of the systematic part depends on its accuracy and its usefulness. Descriptions should be provided for all genera as well as subgeneric taxa, unless no original descriptions exist; and it is regrettable that no descriptions are provided for several species recorded [e.g., *Lachnocladium brasiliense* Lev. on p. 31, *Clavicornia pyxidata* (Fr.) Doty on p. 33, *Scytinopogon angulisporus* (Pat.) Corner on p. 39]. In most of these cases the author states that no descriptions were given for the Indian material by the recording author. While the monographer is justified in being doubtful about some determinations, the listing of these taxa would indicate provisional acceptance of these records pending further study and so descriptions of these taxa from a monograph or other suitable source should have been given. Thus, descriptions are wanting for at least 20 of the 92 taxa, excluding those for which no original descriptions are available at all such as *Pterula penicellata* Lloyd (p. 29). Where descriptions are provided, the author could have indicated clearly whether these are derived from descriptions given by the recording authors, or from specimens collected and studied by the author himself, from original descriptions or from a monograph. The value of the descriptions would depend on their source, and original descriptions or redescrptions based on type or authentic material are to be preferred. On p. 26 the author states: "While preparing keys for the species of various genera recorded from India, I have made free use of the characters of the Indian types while still maintaining the broader concept of the species." What does this mean? Does this indicate that the author has his own "broader concept of a species" quite distinct from species concepts and descriptions based on types? If so, the impact of these on the circumscription of the taxa would be enormous. References pertaining to Indian records are sometimes difficult to locate since these are merged with the taxonomic literature citations given immediately after the names of the taxa listed. These could have been better cited along with details given under the heading "Locality". The synonymy is apparently based on Corner's work, but there is no order in the arrangement of the synonyms.

The reviewer has just set forth merely a point of view suggestive of possible improvements when this work will doubtless be revised and enlarged by the author who continues to work in this field most actively. The present work is not only adequately illustrated with clear line drawings for which the magnifications are indicated, but is also provided with a glossary and an index. It is built on the framework of Corner's classification, and in bringing together Indian records in one volume the author has made a significant contribution to the literature on Indian fungi. It certainly represents a step forward in the synthesis of information on Indian fungi and Dr. Thind has admittedly fulfilled a difficult task in having contributed very considerably to our knowledge of the Indian Clavariaceae. In any case, this book is bound to stimulate further work and, if it does, both author and publisher will have been amply rewarded. C. V. SUBRAMANIAN.

---

**Comparative Nutrition of Man and Domestic Animals, Vol. I.** By H. H. Mitchell. (Academic Press, New York and London), 1962. Pp. xxi + 701. Price \$ 25.00.

Professor Mitchell has written an excellent book on the comparative nutrition of man and animals. The author has had long teaching and research experience in these fields and is well known for his research work on nutrition. His authoritative book is written in lucid style and contains a critical and masterly account of present knowledge in the field of comparative nutrition. The present volume deals with the nutrient requirements for maintenance, growth, reproduction and lactation. The treatment throughout has been thorough and includes all recent developments on the subject. Extensive references to important research publications are given. The book will prove an indispensable reference manual to advanced students and research workers in the field of animal and human nutrition. M. SWAMINATHAN.

---

**Microaerosols—Physiology, Pharmacology and Therapeutics.** By L. Dautrebande. (Academic Press, London), 1962. Pp. xii + 366. Price \$ 13.50.

The extremely fine dispersion up to 20 million particles per ml. of air, made possible by the process of 'obligatory liquid filtration' by aerosol generators described by the author is an interesting development in the field of inhalation therapy.

This volume presents in detail production, sampling numbering and sizing of the aerosol particles and the intimate relationship between the particle size and therapeutic efficiency of drugs introduced into the system by aerosol technique. Data on the deposition of air-borne particles at various levels of the respiratory tract, pharmacological effects of drugs affecting the autonomic nervous system and experimental details pertaining to the comparative evaluation of constrictor and dilator drugs administered by aerosol technique, the use of aerosols in respiratory diseases and the systemic effects of liquid aerosols presented in the various chapters lucidly explain the basic principles of aerosol therapy and the usefulness of this method in the treatment of both respiratory and systemic affections.

M. SIRSI.

**Proceedings of IGY Symposium (Vol. I).** (Council of Scientific and Industrial Research, New Delhi), 1962. Pp. x + 246. Price Rs. 18-00.

The International Geophysical Year (IGY) which lasted from July 1, 1957 to December 31, 1958 marked the unique co-operation of all the countries of the world in a scientific undertaking of a kind unprecedented in the history of science in recent times. A great wealth of data in different fields of study have been accumulated which will yet take a long time to co-ordinate and interpret. They will form the basis of much work for expansion in those and allied disciplines to which the IGY was devoted. India's participation in the IGY was of special significance because of the fact that the geomagnetic equator passes through the southern part of the country.

At a symposium organised by the Council of Scientific and Industrial Research (CSIR), New Delhi, in February 13-16, 1961, the Indian work was discussed in a number of papers presented by Indian scientists who actively took part in the IGY programme. These papers are being published by the CSIR in two volumes.

The first volume under review contains about 40 papers on ionospheric data arranged under the following main heads: (1) Ionospheric Morphology and True Height Profiles; (2) Ionospheric Drift; (3) Ionospheric Absorption; (4) Solar Terrestrial Relationships; (5) Ionospheric Irregularities. The volume opens with a survey article on "Advances in Ionosphere and Aeronomy during IGY" by Dr. A. P. Mitra of the National Physical Laboratory, New Delhi.

**Methods of Experimental Physics (Vol. 5)—Nuclear Physics (Part B).** Edited by L. C. L. Yuan, and Chien-Shiung WU. (Academic Press, Inc., 111, Fifth Avenue, New York-3), 1963. Pp. xviii + 886. Price \$ 22.50.

The two volumes, devoted to Nuclear Physics in this series *Methods of Experimental Physics*, give a comprehensive and critical account of the various methods employed in the measurements of physical quantities involved in nuclear physics. Both high energy and low energy phenomena are considered.

In Part B under review the section on "Determinations of Fundamental Physical Quantities" are continued from Part A and the various sections under this heading deal with mass, spin, parity, nuclear moments, electron and photon polarization, lifetime, and flux densities. Under "Sources of Nuclear Particles and Radiations" are discussed the natural radioactive sources, and the artificial low, medium, and high-energy sources of various types. The third section on "Beam Transport Systems" discusses beam bending and focusing systems, and beam separators. The last section on "Statistical Fluctuations in Nuclear Processes" includes frequency distributions, statistical characterisation of data, composite distributions and tests for goodness of fit.

Thirty-one authors have contributed to this volume. As a reference work giving the latest in this growing field of research the two volumes will be welcomed by students of nuclear physics.

**IMDA—Trade Directory.** *Directory of Instrument Manufacturers and Dealers in Maharashtra and Gujarat.* (The Bombay Regional Council of All-India Instrument Manufacturers and Dealers Association, Bombay-7), 1963. Pp. 100. Price Rs. 5-00.

The Bombay Regional Council of the All-India Instrument Manufacturers and Dealers Association (IMDA) has brought out a Directory of instrument manufacturers and dealers in the Maharashtra and Gujarat States.

Out of the total 100 pages, the Directory proper contains two sections, the first of 17 pages giving the addresses (with the telephone number) of the firms in the instruments line, and the second of 15 pages giving a classified list of 10 broad categories of instruments with the list of firms dealing with each category.

There is a need for a publication of this type. In fact many who use scientific instruments of various types are not aware of where to get

exactly what they want. The proposed publication on an all-India basis will be welcomed.

Considering that half the number of pages are advertisements or display sheets for the firms and dealers concerned, and indeed the other half also is a sort of publicity for them, one fails to see why a publication of this type should be priced at all, and that too at such a high rate as the present one. It is likely to defeat its purpose of making the publication available to all who need it.

A. S. G.

---

*Fish as Food*, Vol. II. Edited by George Borgstrom. (Academic Press, New York and London), 1962. Pp. xvii + 777. Price \$ 25.00.

The second volume of the book—*Fish as Food*—is divided into three parts, Nutrition, Sanitation and Utilization. In addition to the editor of the volume George Borgstrom, who has himself been the author of a few chapters, a number of experts in various specialized branches have reviewed the present-day position in respect of fish science. From a perusal of extensive references at the end of each chapter it is clear that there is a very wide coverage of the available literature of subjects dealt with in this volume.

In the part Nutrition, are given the details of nutritive aspects of fish and shell-fish protein, fish oils, vitamins and mineral constituents of fish. There are also chapters on changes in nutritive values in handling and processing and on fish meal. The part on Sanitation deals with varied aspects of food poisoning in fish and fishery products, fish-borne food poisoning, contamination caused by polluted waters, fish diseases, live fish transportation and hazards of radioactivity. The part on Utilization deals with various aspects of processing technology.

This volume is of particular interest to India as all aspects dealt with therein are currently engaging the attention of fishery workers and administrators in India at present. Quality control or wholesomeness of preserved products is not only important from the public health point of view but also essential for building up an effective export market. This volume is one of the best so far published on fish science and deserves to be added to every fishery and university library.

B. S. BHIMACHAR.

### Books Received

From : Academic Press, Inc., 111, Fifth Avenue, New York-3, N.Y. :

*Space Carrier Vehicles Design, Development and Testing of Launching Rockets*. By O. H. Lange and R. J. Stein, 1963. Pp. vii + 317. Price \$ 12.00.

*Pathology of Domestic Animals* (Vol. I). By K. V. F. Jubb and P. C. Kennedy. Pp. xiii + 477. Price \$ 18.00.

*Mechanisms of Virus Infection*. Edited by Wilson Smith, 1963. Pp. ix + 368. Price 80 sh.

*Chemical Plant Taxonomy*. Edited by T. Swain, 1963. Pp. ix + 543. Price 110 sh.

*Energy-Linked Functions of Mitochondria*. By Britton Chance, Pp. xi + 282. Price \$ 4.50.

*Methods in Computational Research—Advances in Research and Applications—Vol. I—Statistical Physics*. Edited by B. Alder, S. Fernbach and M. Rotenberg, 1963. Pp. xi + 304. Price \$ 10.00.

*Newer Methods of Preparative Organic Chemistry*. Edited by W. Foerst and F. K. Kirchner, 1963. Pp. xv + 425. Price \$ 14.50.

*International Geophysics Series* (Vol. 4)—*Air Chemistry and Radioactivity*. By C. E. Junge, 1963. Pp. xii + 382. Price \$ 13.50.

*Advances in Electronics and Electron Physics* (Vol. 17). Edited by L. Marton, 1963. Pp. x + 451. Price \$ 14.00.

*The Chemistry and Function of Proteins*. By F. Haurowitz, 1963. Pp. xiv + 455.

*Mass Spectrometry of Organic Ions*. By F. W. Mac Lafferty, 1963. Pp. xii + 730. Price \$ 24.00.

*Pathology of Domestic Animals* (Vol. 2). By K. F. F. Jubb and P. C. Kennedy, 1963. Pp. xv + 613. Price \$ 24.00.

*Interfacial Phenomena*. By J. T. Davies and E. K. Rideal, 1963. Pp. xiii + 480. Price \$ 15.00.

*Analytical Methods for Pesticides, Plant Growth Regulators and Food Additives* (Vol. I)—*Principles, Methods and General Applications*. By G. Zweig, 1963. Pp. xiv + 637. Price \$ 24.00.

*International Review of Cytology*. Edited by G. H. Bourne and J. F. Danielli, 1963. Pp. ix + 444. Price \$ 16.00.

*Methods of Enzymatic Analysis*. Edited by H. U. Bergmeyer. (Translated from German. by D. H. Williamson), 1963. Pp. xxiii + 1064. Price \$ 30.00.

*Crystallography and Crystal Perfection*. By G. N. Ramachandran, 1963. Pp. x + 374. Price 75 sh.

## SCIENCE NOTES AND NEWS

### Award of Research Degrees

Andhra University has awarded the D.Sc. degree in Technology to Shri K. Somasundara Rao for his thesis entitled "Studies on Mass Transfer at Vibrating Cylinders", and the Ph.D. degree in Physics to Shri A. V. Krishna Rao for his thesis entitled "Absorption Spectra of Biphenyl Single Crystal, Certain Methyl Naphthalene diphenyl acetylene and acrolein".

Gujarat University has awarded the Ph.D. degree in Physics to Shri J. S. Shirke, of the Physical Research Laboratory, Ahmedabad, for his thesis entitled "Investigations on the Physics of the Ionosphere over Ahmedabad".

Calcutta University has awarded the D.Sc. degree to Shri B. N. Ghosh for his thesis entitled "Physiological and Agronomic Studies on Rice with Special Reference to the Agricultural Problems of India".

### Geophysical Symposium

The Geophysics Research Board, Council of Scientific and Industrial Research, will hold a Symposium on 'Problems in Geophysics relating to the Crust of the Earth' in January 1964. The scope of the Symposium will be limited to problems in Geodesy, Seismology, Oceanography, Geophysical Exploration, Geochronology and Physical Properties of Rocks.

Further information can be obtained from Dr. S. Balakrishna, Assistant Director, National Geophysical Research Institute, Osmania University Campus, Hyderabad-7 (A.P.).

### Birbal Sahni Institute of Palaeobotany, Lucknow

The Sixteenth Annual Scientific Meeting of the Palaeobotanical Society will be held at the Institute's premises on the 21st and 22nd January 1964. The programme will include lectures, reading of papers, etc.

Further information can be obtained from the Registrar of the Institute.

### Journal of Applied Probability

The Applied Probability Trust, in association with the London Mathematical Society, is to publish a new international Journal devoted to the applications of probability theory to the biological, physical, social and technological sciences.

The *Journal* will be issued in two half-yearly numbers forming a volume of about 300 pages per annum, starting in May-June 1964. It will include: (1) review papers surveying a field of applied probability; (2) research papers; and (3) short communications.

Annual subscriptions: institutions—U.S. \$ 12.00, £ 4.4.0; individuals—U.S. \$ 8.00, £ 2.16.

Further information can be obtained from the Editor-in-Chief, Dr. J. Gani, Department of Statistics, The Australian National University, P.O. Box 4, Canberra, Australia.

### Control of Gujarat Hairy Caterpillar (*Amsacta moorei* Butler) by Tilodrin

Messrs. H. K. Patel, V. C. Patel and R. C. Patel, Department of Entomology, B.A. College of Agriculture, Institute of Agriculture, Anand, write:

*Amsacta moorei* Butler, commonly known as the Gujarat hairy caterpillar, is a serious pest in the Gujarat State attacking various crops grown after the first rains in their early stages. The caterpillar is a polyphagous and voracious feeder and in case of serious infestation destroys the whole crop necessitating resowing.

Tests with various insecticides indicated that endrin and methyl parathion were satisfactorily effective. However, early in 1962 M/s. Burmah-Shell, New Delhi, supplied a free sample of Tilodrin (1, 3, 4, 5, 6, 7, 8, 8-Octachloro-3  $\alpha$ , 4, 7, 7  $\alpha$ -tetrahydro-4, 7-methanophthalan) in the form of 15% W/v emulsifiable concentrate for testing it against various crop pests. Preliminary tests with Tilodrin conducted in 1962 were encouraging and gave 100% control within 72 hours.

To confirm the above results and also to compare its effect with other insecticides the experiment was repeated during 1963 with the following treatments: (1) Tilodrin 0.14% emulsion spray at 50 gal./acre; (2) Endrin 0.05% emulsion spray at 50 gal./acre; (3) Methyl parathion 2.0% dust at 20 Kg./acre; (4) Control.

The results obtained from the above experiment indicated that Tilodrin 0.14% was the best treatment giving 100% control within 48 hours of the treatment under field conditions. The percentage kill obtained with methyl parathion 2.0% dust and endrin 0.05% spray was 90.2%

and 83.0% respectively 72 hours after the treatment.

### 80-Inch Bubble Chamber

The Brookhaven National Laboratory has announced the first successful operation of its new 80-inch liquid hydrogen bubble chamber used along with the BNL 33 BeV. Alternating Gradient Synchrotron for study of subnuclear particles.

The 1,500-litre stainless steel chamber, weighing about ten tons, contains liquid hydrogen at  $-414^{\circ}\text{F}$ . and 70 lb./sq. inch pressure. Under these conditions hydrogen presents the characteristics of a superheated liquid, ready to 'boil' when the pressure is reduced. When a stimulus, such as a charged subnuclear particle, is introduced into the liquid hydrogen, boiling takes place along the track of the particle, thus producing a visible track of bubbles (over 20 to the inch), which can be photographed by four special cameras located behind a  $6\frac{1}{2}$ -inch thick glass window on one side of the chamber. By the synchronization of these cameras with a high voltage fast-pulsed light source, together with the entering beam, of bombarding particles and the motion of the 36-inch diameter piston controlling the pressure in the chamber, photographs are taken for each pulse of particle from the synchrotron. Then, by increasing the pressure, the bubbles in the chamber are made to disappear, erasing the tracks and making the chamber ready for the results of another pulse.—(*Journ. Frank. Inst.*, 1963, 273, 185).

### Europium Orthosilicate—A New Transparent Ferromagnet

The known number of ionic compounds which become ferromagnetic is limited to only a few materials; among these are the recently discovered europium compounds. M. W. Shafer *et al.* report the discovery of a new ferromagnetic europium compound which is optically transparent in bulk. It has the composition  $\text{Eu}_2\text{SiO}_4$  and, according to the usual silicate classification, would be called orthosilicate.

Magnetization measurements were made both on powders and single crystal specimens. These specimens were plate-like crystals, transparent and with natural faces 2–3 mm. across and 0.05 to 0.1 mm. thick. The complete structure of  $\text{Eu}_2\text{SiO}_4$  is not known, but it has been indexed as an orthorhombic cell,  $a = 9.71 \text{ \AA}$ ,  $b = 49.56 \text{ \AA}$  and  $c = 5.65 \text{ \AA}$  with 28 formula units per cell. There appears to be layering along the direction of the  $b$ -axis, and hence the true  $b$

parameter repeats every seven layers. The fact that  $\text{Eu}_2\text{SiO}_4$  is an orthosilicate means that we have an assembly of discrete  $\text{SiO}_4$  tetrahedra with  $\text{Eu}^{++}$  in the holes between them, probably in six-fold co-ordination.

Ferromagnetism of  $\text{Eu}_2\text{SiO}_4$  is clearly indicated by the shape of the magnetization curves (at  $4.2^{\circ}\text{K}$ .) and from the positive  $\theta$  intercept of the reciprocal susceptibility curve.—(*Phys. Rev. Letters*, 1963, September 15.)

### Evidence for Supersupernovae Explosion

Optical evidence has been found in support of the hypothesis that the strong radio emission of certain galaxies may have its origin in titanic explosions of "supersupernovae." The possibility of such explosions has been discussed recently by Hoyle and Fowler. They have postulated an explosion mechanism involving the gravitational collapse of an enormous volume of gas 1 million to 10 million times the mass of the sun. Whether or not such a mass can actually exist as a single star is still open to question. Hoyle and Fowler have simply offered the hypothesis as a way of explaining how a strong radio galaxy can emit radio energy equal to the thermonuclear output of all its stars.

Evidence for an explosion of the magnitudes postulated by Hoyle and Fowler is reported in the *Astrophysical Journal* by Lynds and Sandage. The two workers made a photographic and spectrographic study of the irregular galaxy M 82, which is a strong radio source, and found that great quantities of luminous gas are streaming outward from the centre of the galaxy at velocities about 1000 km./sec. The streaming matter shows up as a massive system of bright filaments that appear to be tangled with magnetic lines of force. The filaments have many of the characteristics of those found in the Crab nebula, the remains of an exploding star in our own galaxy.

The energy contained in the M 82 filaments, however, is many orders of magnitude greater. The mass of the expanding material has been calculated as  $5.6 \times 10^6$  solar masses, and an upper limit to the kinetic energy of the moving gas has been put as  $2.4 \times 10^{55}$  ergs.

Lynds and Sandage have proposed that approximately 1.5 million years ago there took place an extremely energetic expulsion of material from the central region of M 82. The expulsion was confined to regions near the mirror axis of the galaxy, because of pressure



in the disc, and was sufficiently energetic to dominate the magnetic field existing in the disc of the galaxy. By some unknown mechanism, relativistic electrons reaching energies of about  $5 \times 10^{12}$  ev were created in the "explosion", and these have radiated radio and optical noise by the synchrotron process for the lifetime of the system. —(*Astrophys. J.*, 1963, 137, 1005.)

### Stimulated Raman Scattering from Lattice Vibrations

As is well known Raman scattering occurs when radiation at frequency  $\omega_1$  passes through a medium having an excited state whose energy  $E_f$  is smaller than  $h\omega_1$ . The scattered radiation has frequency  $\omega_2$  given by  $h\omega_1 = h\omega_2 + E_f$ , and the scattering medium is left in its excited state at the end of the event. Molecular vibration states in liquids and solids have been extensively studied by Raman scattering experiments. In principle other types of low-lying excited states are accessible to Raman effect measurements, for example spin waves, energy levels of rare-earth impurities in crystals, etc.

In the ordinary Raman effect the scattered radiation is emitted *spontaneously* in directions distributed anisotropically over the complete  $4\pi$  solid angle. For practical convenience observations are normally made at right angles to the incident beam, to exclude from the spectrograph as much as possible of the radiation at frequency  $\omega_1$ .

Recently much work has been reported on the *stimulated* Raman scattering from organic liquids using a ruby laser as the source, and making observations in the *same direction* as the incident beam. The coherent well-collimated Raman radiation has intensity up to one-tenth of the incident laser beam intensity. This high intensity of the Raman beam makes possible its spectroscopic resolution from the laser beam, even though their directions are the same.

Stimulated Raman scattering is expected to occur in solids also, and recently at the Third International Symposium on Quantum Electronics held in Paris, Zeiger has proposed a Raman laser which will generate frequencies  $\omega_2$  in the infra-red by stimulated Raman scattering using excited electronic states of impurities in crystals.

In a paper contributed to the *Proceedings of the Physical Society* R. Loudon considers stimulated Raman scattering using lattice vibrations. Extending his theory of spontaneous Raman scattering from phonons (*Proc. Roy. Soc.*, 1963, 275 A, 218), Loudon treats the

problem of stimulated Raman scattering in which the photons and phonons are coupled indirectly *via* the electrons of the crystal, using the electron-photon and electron-phonon interactions.

His results show that the observation of stimulated Raman scattering from lattice vibrations is in principle possible using currently available lasers. In suitable uniaxial crystals such observations will provide information about the very long wavelength polar optical lattice vibrations which is not obtainable by conventional Raman experiments. —(*Proc. Phys. Soc.*, 1963, 82, 393.)

### Ultrasonic Internal Conical Refraction

Analogous to the well-known optical phenomenon is the theoretical prediction that, under suitable conditions, ultrasonic waves should exhibit internal conical refraction when travelling through anisotropic crystals. According to theory the energy flux vector in such propagation lies on a cone whose apex is at the centre of the transducer and whose axis is the wave normal. Evidence for the existence of ultrasonic internal conical refraction in rock salt and calcite single crystals has been obtained by observing the behaviour of shear waves along one of the axes of threefold symmetry in each crystal. To demonstrate the phenomenon a method of selective absorption was used in conjunction with pulse-echo ultrasonic attenuation measurements. In the experiment absorbing material was pasted at various spots on the bottom of the specimen opposite the transducer to map the energy density in the wave. It was observed that positions of maximum flux as obtained from attenuation measurements coincided with predictions according to theory. —(*Jour. Appl. Phys.*, 1963, 34, 2168.)

### New Role for Interferon

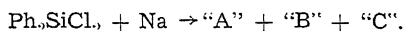
Recent investigations by British scientists have shown that the substance called interferon, which protects the living cell against virus infection, has the general property of protecting the cell from foreign nucleic acids. DNA is the genetic material for living cells, and either DNA or RNA serves as the genetic material as well as the infective component of viruses. When viral nucleic acid enters a cell it introduces "instructions" for the synthesis of new virus particles. Interferon somehow prevents these instructions from being carried out.

Interferon was discovered in 1957 by Isaacs and Lindenmann at the National Institute of Medical Research, London. It is a protein, about three times the weight of the insulin molecules and is produced by cells in response to virus infection. Studies are still in progress to see if interferon, produced in laboratory quantities, can be used as an antiviral agent.

Isaacs conceived the hypothesis that cells might produce interferon in response to any foreign nucleic acid. He tested the idea by exposing chick and mouse cells to chick and mouse RNA. If chick cells were treated with chick RNA (or mouse cells with mouse RNA) no interferon was produced. But if chick cells were treated with mouse RNA (or mouse cells with chick RNA), interferon appeared. It was shown further that if the "acceptable" RNA was altered chemically, it could be converted into a "foreign" RNA capable of stimulating interferon production. These studies suggest that interferon provides the cell with a generalized defense against foreign nucleic acids that is analogous to the defense that antibodies provide against foreign proteins.—(*Scientific American*, 1963, 209, 84.)

#### Cyclic Organopolysilanes : Kipping's "A", "B", "C" Compounds

As early as forty years ago Kipping and co-workers studied the reactions of alkali metals with the relatively low-volatile  $R_2SiCl_2$  compounds where the R groups were generally phenyl. They found that these reactions gave rise to a series of products largely cyclic in nature. From the reaction of dichlorodiphenylsilane with an excess of sodium in no solvent, or toluene, or xylene Kipping obtained several products which he designated as Compounds "A", "B", "C", etc.



Compound "A" was early shown to have four diphenylsilylene units ( $Ph_2Si$ ). However, the mode of arrangement of these units remained a problem, although Kipping had suggested that Compound "A" could best be represented by a structure with two tervalent silicon atoms.

During the course of their intensive investigations on organosilicon compounds Gilman and co-workers had occasion to re-examine the Com-

pounds "A", "B", "C" of Kipping. When a sample of Compound "A" was prepared in accordance with the directions of Kipping, and tested for free radicals no evidence was found for a tervalent silicon. They have shown Compound "A" to have the octaphenylcyclotetrasilane structure with  $SiPh_2$  at each corner of a square.

Compound "B" which was originally supposed to be a six-membered ring has been shown to be a five-membered ring. Support for this chemical evidence has also come from X-ray diffraction and NMR studies. The structure of Compound "C" has not yet been established rigorously but present evidences, especially cleavage by lithium, indicate that it may be a six-membered ring, dodecaphenylcyclohexasilane, with  $SiPh_2$  at each corner of a hexagon.—(*Trans. New York Acad. Sci.*, June 1963, p. 820.)

#### Fourth Seminar on Electrochemistry

The Fourth Seminar on Electrochemistry will be held at the Central Electrochemical Research Institute, Karaikudi-3, from 28th to 31st December, 1963 (both days inclusive). Intending participants and delegates should write to the Convener, Dr. H. V. K. Udupa, Central Electrochemical Research Institute, Karaikudi-3.

#### Desalting Sea-water

A panel of experts convened by IAEA recommended to the Agency a number of steps to develop the use of nuclear reactors for the desalting of sea-water. Statements by the panel show that nuclear plants with the dual purpose of power generation and saline water conversion offer certain economic advantages over plants designed solely for desalination. In arid zones in the developing countries, the installation of power-water schemes is likely to produce cheaper electricity than that produced at present by diesel stations. This will enable governments to utilize the saving to subsidize the water produced, and since the water production costs will also be lower, it will be possible to distribute more water for the same subsidy.—(*International Atomic Energy Agency News*.)

689-63. Printed at The Bangalore Press, Bangalore City, by T. K. Balakrishnan, Superintendent, and Published by S. R. S. Sastry, for the Current Science Association, Bangalore.

All material intended for publication and books for review should be addressed to the Editor, *Current Science*, Raman Research Institute, Bangalore-6.

Business correspondence, remittances, subscriptions, advertisements, exchange journals, etc., should be addressed to the Manager, Current Science Association, Bangalore-6.

Subscription Rates : India : Rs. 12-00. Foreign : Rs. 16-00; £ 1-4-0; \$ 4.00.

# VISUAL ACUITY AND ITS VARIATIONS

SIR C. V. RAMAN

## 1. INTRODUCTION

OUR visual organs are the principal gateways through which a knowledge of the external world finds its way into the realm of human consciousness and in consequence, they play a role of immense importance in human life and activity. Three distinct types of sensation are recognisable in the visual pictures of the outer world presented to us by our eyes, being respectively the binocular perception of space and form, the perception of colour and the perception of luminosity. These perceptions correspond respectively to the three physical characteristics of light considered as electromagnetic wave-motion in space which finds an entry into our eyes, *viz.*, its rectilinear propagation in free space, the length of the waves and the magnitude of the electric-vector in them. The value of the information conveyed by our visual impressions depends greatly on their accuracy. The precision reached in each of the three types of sensation is therefore a highly significant feature of our visual perceptions. They are respectively the acuity of vision, the power of colour discrimination and the photo-sensitivity. These definitive characteristics of our subjective sensations are of great importance in all considerations regarding the *modus operandi* of the physiological perception of light.

Reference was made above to the properties of light regarded as electromagnetic wave-motion in space. But in considering the sensory perception of light following its incidence on the retinae of our eyes, these properties cease to be relevant, and we have, instead, to consider light in its quantum-theoretical aspects, in other words, as consisting of discrete quanta of energy. For, the absorption of light by the visual receptors is a necessary condition for its perception and such absorption takes place in complete quanta of energy. It follows that in seek-

ing for an explanation of the various features characteristic of the visual perception of light, we have necessarily to proceed on the basis of the quantum theory. In particular, the acuity of vision, the power of colour discrimination and the sensitivity of our eyes to differences of intensity have all to be understood or interpreted on that basis. Though it is convenient to separate these three aspects of vision in describing and discussing the results of observation and experiment, they are, in reality, so closely inter-related that we have necessarily to adopt the same fundamental basis of approach for elucidation in all the three cases.

## 2. COLOUR AND THE QUANTUM THEORY

The intimate relationship between the theory of light-quanta and the physiological effects of light becomes evident when we consider the sensations excited by the monochromatic rays of the spectrum. As we proceed from the red to the violet end of the spectrum, the magnitude of the energy-quantum in light increases progressively and continuously. Likewise, we perceive a continuous progression of colour, and there is thus a one-to-one correspondence between the perceived colour and the magnitude of the energy-quantum. We are, therefore, justified in regarding every one of the numerous distinguishable colours in the spectrum—of which there are some 150 or more—as primary or fundamental physiological sensations. The so-called trichromatic hypothesis which assumes that there are only three fundamental colours or only three fundamental sensations has, therefore, no logical basis and is unsustainable. The explanation of the known facts regarding the perception of monochromatic light—namely the variations of the luminous efficiency and the variations of the power of colour discrimination noticed as we proceed along the spectrum from end to end—is to be found in the specific characteristics of the absorbing

materials which function as the receptors in the retina. We shall not here pause to discuss these matters further, but will pass on to consider the subject of the acuity of vision on the basis of the quantum theory. This subject is, indeed, the principal topic to be dealt with in the present communication.

### 3. THE FACTORS INFLUENCING VISUAL ACUITY

In any discussion of the subject of visual acuity, we have to assume that the functioning of the dioptrics of the organs of vision is perfect. This, of course, is not necessarily always the case. But since the various possible defects in such functioning can be corrected more or less perfectly after ophthalmoscopic examination, they need not trouble us here. Chromatic aberration in the eye and its elimination by the use of monochromatic light are, however, not unimportant in the present context. The two factors which most notably influence visual acuity are, firstly, the region of the retina which is made use of, and secondly, the intensity of the illumination employed. Other factors are the spectral nature of the illumination, the distribution of light in the object under view and the illumination of the surrounding field. We shall here briefly recall some well-established facts regarding these matters.

When we wish to observe any object closely, we turn our eyes and accommodate their focus so as to ensure that the image of the object falls precisely on the foveal region of the retinae of both eyes. It is well known that the visual acuity is highest when the region under observation falls precisely at the centre of the fovea and that it falls off with extreme rapidity when the image moves away from that position. A movement of  $10^\circ$  in either direction is sufficient to reduce visual acuity to 20% of its maximum value, while a displacement of  $20^\circ$  brings it down to 10% of the maximum. Beyond this again, the acuity for daylight vision continues to fall off, but more slowly.

The influence of the intensity of illumination on visual acuity is a matter of familiar

experience. The acuity is highest at high illuminations and falls off, at first slowly, and then much more quickly, and becomes a small fraction of its maximum value when the illumination is weak, even when it is well within the photopic range. These changes in the acuity of vision with diminishing illumination becomes evident, for example, when we seek to read the pages of a printed book by daylight in the late hours of the afternoon when the sun is about to set and before it has actually become dark. The smaller the print, the greater is the difficulty felt in recognising the letters on the page.

The influence of the spectral nature of the illumination on acuity is, speaking broadly, of the nature which might be anticipated from the consideration that the luminous efficiency of radiation varies enormously as between different parts of the spectrum. The acuity is, in fact, found to be greatest in the part of the spectrum which has the highest luminosity, the order being yellow, orange, green, red and blue. It is particularly low at and near the blue end of the spectrum which has a very low intrinsic luminosity.

Since visual acuity usually depends on the perception of differences in the luminosity of adjoining areas in the field of vision, it naturally falls off as these differences diminish. Likewise, it has been found that for a given brightness of the test-object, the acuity improves as the surround illumination is increased, until the brightness of surround and test-object are equal. A further increase of surround illumination then causes a rapid fall in acuity.

### 4. THE MEASUREMENT OF VISUAL ACUITY

What precisely we mean by visual acuity depends on the nature of the object or objects under examination. It follows that there are several different ways in which the acuity may be defined and measured. One of the classic definitions is our ability to distinguish two stars in the night sky which are very close together as distinct objects. Amongst other tests may be mentioned, the

discrimination of two parallel lines, the alignment of a vernier, the recognition of a break in a contour, the recognition of a localised thickening in the circumference of a circle, or the appearance of a crossed pair of gratings held together at various angles with respect to each other. Amongst other devices which have been employed may be mentioned the broken circle of Landolt where a circle with a gap is presented and the observer is asked to say in what segment the gap lies.

A commercially available test-object for the study of the variations of visual acuity is the chart regularly used by ophthalmologists for detecting and correcting defects in vision. These charts are sets of letters arranged in a descending order of size. The observer sits at a convenient distance away from the chart (say 6 metres) and his vision is expressed as a fraction of this distance and the theoretical distance at which the letters should be read on the basis of a minimum visual angle of one minute of arc. Using such a chart, the changes in visual acuity manifesting themselves in normal vision when the illumination is varied can be readily observed and measured. In such measurements, three different procedures may be adopted. Keeping the illumination constant, the observer may note the effect of his gradually approaching the chart in making the smaller letters appear distinct. Alternatively, the observer remaining in the same position with respect to the chart, the power of the light source may be varied. The third procedure is for the source and the observer to remain in the same position and to move the chart away from them so that both the illumination of the chart and the angular dimensions of the letters progressively diminish. All three procedures yield comparable results.

#### 5. THE PHYSIOLOGICAL BASIS OF ACUITY

It is evident that for very fine detail of the object under observation to reveal itself to our perceptions, two conditions must be satisfied. Firstly, well-defined optical

images of the object should be formed on the retinae of our eyes. Secondly, there should be present on the area of the retina where such images are formed, a sufficiently close-packed mosaic of receptor-elements that can receive the incident light-image and transmit the details thereof to the visual cortex. But there is also a *third* and highly important condition to be satisfied which emerges as a consequence of the constitution of light itself, *viz.*, that it consists of discrete quanta of energy which must be absorbed as such by the visual receptors before the light can be perceived. We shall now consider each of these three conditions separately and comment on the influence exercised by them on visual acuity.

We have already referred to the first condition which should be satisfied for the highest acuity of vision to be possible. Even apart from any imperfections in the dioptric media of the eye, chromatic aberrations and the diffraction of light by reason of the limitation of aperture by the pupil of the eye have necessarily to be taken into account. The limitations set by these factors on visual acuity are well understood and we need not pause here to discuss them in detail. The fine structure of the retina, in other words, the size of the individual cones which are recognised as the receptors in daylight vision, and the manner which they are disposed relatively to each other determines the possibility of the details of the retinal image being conveyed to the visual cortex and thereby find a place in the perceived image of the object. The nature of the connections between the retina and the visual cortex is an important factor in this respect. The evidence that has been found that individual nerve-fibres carry the nerve-impulses from the receiving cones to the sensorium makes it easier to understand how the observed acuity of vision is attained.

It is with the *third* factor influencing the acuity of vision with which we are here specially concerned. The observed diminution of the visual acuity which accompanies

a fall in the illumination of the objects under study finds a natural explanation on the basis of the principles of the quantum falling on each element of area of the retina to put forward a rational explanation of the observed facts on any other basis. If the optical image formed on the retina is to be transmitted without loss of detail to the visual cortex, the number of quanta of energy falling on each element of area of the retina and actually absorbed by it and passed on to the visual centres in the brain should be such that each cone in the area under consideration can function fully and effectively. This would obviously not be possible if the flux of illumination falling on the retina is too small, or if the absorbing power of the retinal pigments is inadequate to capture all the incident light-quanta, and make them

available for visual perception. The fact that photopic vision can adjust itself to very high levels of illumination is an indication that the visual pigments present in the retina are not capable of absorbing more than a very small percentage of the incident light-quanta. If, in addition, the retinal illumination is itself of low intensity, not more than a small fraction of the cones in the retina can actually be functioning in any small interval of time—such as, say, one-hundredth part of the second—and a dropping off of the visual acuity to very low values is then inevitable. A simple calculation which takes account of the number of light-quanta incident on the retina during any such small interval of time and the number and spacing of the receptor-elements, *viz.*, the cones present in the area shows that this explanation is sustainable.

### SQUALLS IN INDIA

K. RAGHAVAN AND N. D. NAGARKAR

*Meteorological Office, Poona-5*

**I**N the design of buildings, bridges, chimneys, dams, light-houses, transmission poles, etc., the engineers have to take into account various aspects of destructive winds. The need for information on such winds in different parts of the country is on the increase.

From the point of engineering the destructive winds can be classified into two types—(i) winds associated with squalls which are transient local phenomena lasting for a couple of minutes and (ii) winds associated with large-scale phenomena like cyclones and depressions that last for a longer time affecting a wider area.

Here we shall consider only the squalls. Technically a squall is a sudden increase of wind speed by at least 3 stages on the Beaufort scale, the speed rising to force 6 (39 to 49 km.p.h.) or more, and lasting for at least one minute. In Assam and Kashmir there is no observatory equipped with anemograph to record squalls. The present study therefore refers to the rest of India for which 7 to 13 years data are readily available for a fairly good network of 25 stations given in Table I. It may be pointed out that the conclusions based on these short period data are tentative and intended to give only a very broad picture of the outstanding features of squalls.

### DISTRIBUTION OF SQUALLS

From the distribution of mean annual number of squalls (Fig. 1), it is seen that a maximum of 50 to 70 squalls occur a year in S. Kanara and Kerala while a minimum is observed in Rajasthan and Gujarat and east of the Western Ghats over Deccan plateau. A large part of North India and the Coastal Andhra Pradesh also experience such small number of squalls, less than 20 per year.

In India squall is mainly a hot weather phenomenon. Over 60% of the annual squalls occur during the months March to September. It can be seen from Fig. 1 that certain regions experience practically all the squalls during a couple of months. For instance, the Punjab experiences as much as 80% of the total annual squalls during the period March to July. With the approach of the cold weather season the frequency of squalls rapidly decreases all over the country. During the months December and January, frequencies of squalls are negligibly small.

### DIRECTIONS OF SQUALLS

Squalls may approach a place from any direction. On certain days they have been reported with directions diametrically opposite from two stations situated a few kilometres apart. Further

there have been instances when the same place experienced two or more squalls on the same day from different directions. Despite these vagaries, it seems from an analysis of the

squalls for want of long period data. But the relation between the mean directions of squalls and the upper wind directions indicated by the available data for the pre-monsoon period seems

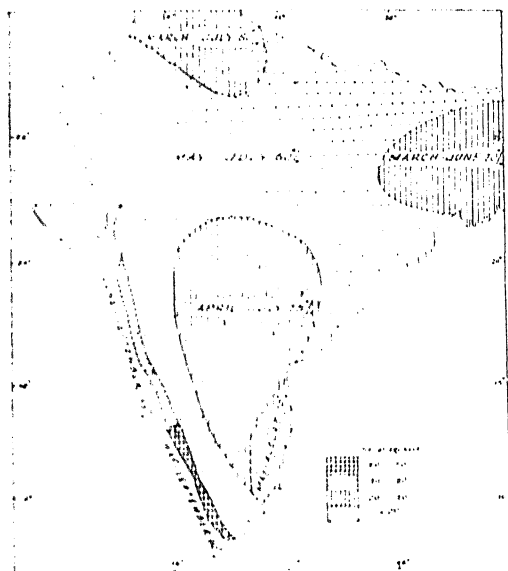


FIG. 1. Mean annual number of squalls and their period of maximum frequency.

directions of squalls that during the pre-monsoon and monsoon seasons squalls tend to blow from a particular direction depending upon the region. From the wind roses of squalls given in Fig. 2(a) for the pre-monsoon period (March to May), it can be seen that the general directions of squalls in N. India differ considerably from those in S. India. They are mainly west north-westerly in N. India becoming north-easterly in S. India after a clockwise change. A careful study has revealed that these general directions are fairly comparable with the prevailing winds in the afternoons at 3 km. a.s.l. To depict this curious relation the stream lines of the afternoon winds at 3 km. for the typical month of April are superposed on the wind roses in Fig. 2 (a).

During the monsoon season (June to September) the general directions of squalls over S. India are mainly westerly [Fig. 2 (b)]. Over the Punjab, Rajasthan and U.P. they are mainly north to north-easterly. Squalls are very variable in direction in Bihar and Bengal. For the months October to February the squalls are too few in number to give a useful indication of their general directions. Even for the pre-monsoon and monsoon seasons discussed above it may be remembered that complete reliance cannot be given to the mean directions of

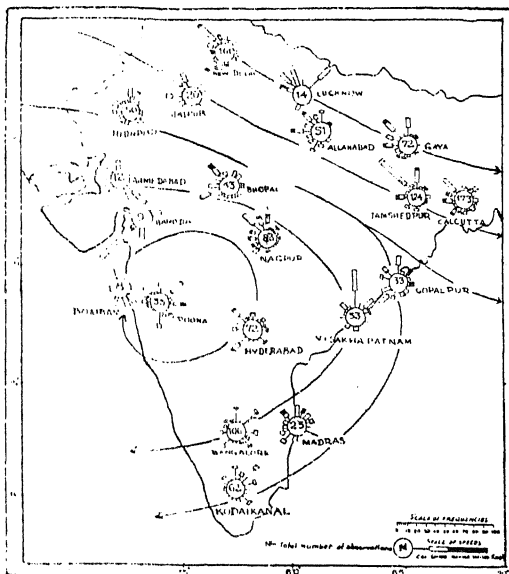


FIG. 2 (a). Wind roses for squalls in pre-monsoon season and stream flow of afternoon winds at 3 km. a.s.l.

to be an important aspect which, when confirmed with the help of more data, may help us to get an idea of the general directions of squalls over regions where actual observational data may not be available.

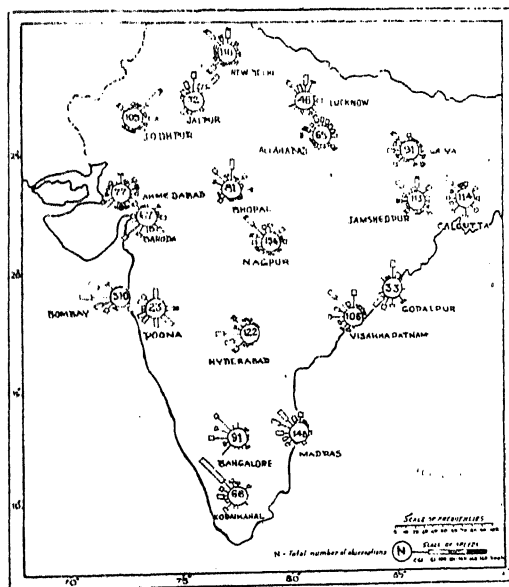


FIG. 2 (b). Wind roses for squalls in monsoon season

## MAXIMUM GUST SPEED

In Table I are given the maximum wind speeds in gusts associated with squalls at all the stations. The highest wind speed so far observed is 163 km.p.h. at Allahabad, on 21 March 1950. A large part of the Gangetic plain is vulnerable to such violent squalls whereas in the west coast of the Peninsula squalls have not so far exceeded a speed of 97 km.p.h.

life period. Even in the case of structures so designed, their life period will be shortened if the structures are subjected frequently to severe stress and strain by strong winds. In view of this the engineers are required to take into account not only the maximum wind speed but also the frequencies of less violent winds that can bring about early fatigue to different parts of a structure.

TABLE I  
Statistics of squalls in India

Station	Latitude °N.	Longitude °E.	Height of Anemograph above ground (metres)	Period of data	Maximum wind speed in gust (km. p. h.)	Frequencies of Squalls of different wind speeds (km. p. h.)				
						141- 160	101- 140	60- 100	<60	Total
New Delhi	28° 35'	77° 12'	19.8	1948-1960	159	1	12	182	110	305
Jaipur	26° 49'	75° 48'	18.3	1950-1960	144	1	0	36	19	56
Lucknow	26° 45'	80° 53'	13.7	1954-1960	119	0	3	33	29	65
Jodhpur	26° 18'	73° 01'	18.3	1948-1960	151	2	6	102	48	158
Allahabad	25° 27'	81° 44'	12.2	1948-1960	163	1	7	70	54	132
Gaya	24° 45'	84° 57'	13.9	1951-1960	127	0	5	78	92	175
Bhopal	23° 16'	77° 21'	11.7	1952-1960	111	0	3	66	68	137
Ahmedabad	23° 04'	72° 38'	14.8	1953-1960	109	0	2	27	65	94
Jamshedpur	22° 49'	86° 11'	15.5	1951-1960	150	1	15	156	82	254
Dum Dum	22° 39'	88° 27'	20.0	1949-1960	147	1	11	144	96	252
Alipore	22° 32'	88° 20'	26.5	1948-1960	124	0	7	186	119	312
Baroda	22° 18'	73° 15'	21.9	1948-1960	90	0	0	28	52	80
Saugar Island	21° 45'	88° 03'	15.5	1951-1960	119	0	4	105	42	151
Nagpur	21° 06'	79° 03'	15.6	1950-1960	137	0	9	131	118	258
Gopalpur	19° 16'	84° 53'	9.7	1951-1960	109	0	2	48	31	81
Santa Cruz	19° 07'	72° 51'	15.1	1953-1960	93	0	0	53	69	122
Colaba	18° 54'	72° 49'	25.9	1948-1960	97	0	0	218	314	532
Poona	18° 32'	73° 55'	39.6	1948-1960	119	0	3	65	24	92
Visakhapatnam	17° 43'	83° 14'	12.2	1948-1960	120	0	1	77	104	182
Hyderabad	17° 27'	78° 28'	18.5	1954-1960	145	1	4	80	109	194
Meenambakkam	13° 00'	80° 11'	25.0	1951-1960	136	0	2	120	86	208
Bangalore C.O.	12° 58'	77° 35'	19.2	1949-1960	106	0	1	51	156	208
Bangalore F.O.	12° 57'	77° 38'	16.1	1954-1960	84	0	0	50	121	171
Kodaikanal	10° 14'	77° 28'	15.2	1948-1960	93	0	0	54	84	138
*Cochin	09° 58'	76° 14'	12.8	1943-1952	93	0	0	104	609	713

\* Anemograph maintained by the Cochin Port Trust.

From the heights of anemographs given in Table I it can be seen that the heights to which these winds refer vary from station to station. At present there is perhaps no accepted factor by which one can reduce these wind speeds to a common height. The observed values may perhaps be fairly applicable up to a maximum height of about 30 metres above ground in general.

## FREQUENCY OF GUST SPEED

From the point of design engineering, information on maximum wind speed alone is of little use because the high winds of destructive nature observed over a region may be a very rare phenomenon occurring once in 50 or 100 years which may be more than the normal life period of the proposed structure. In that case, from the point of economy, structures will have to be designed to withstand the maximum wind that is expected to occur within their normal

Therefore in Table I are given the frequencies of squalls of wind speeds 141 to 160, 101 to 140, 60 to 100 and less than 60 km.p.h. This shows in the first instance that winds above 140 km.p.h. are rather a rare phenomenon confined mainly to the north of lat. 22° N. and occurring at the most twice in about 10 to 12 years. Less violent winds of the order of 101 to 140 km.p.h. occur about once in every year in the Punjab and Bengal. Elsewhere their frequency is much less, the west coast of the Peninsula remaining altogether free from such squalls. This part of the Peninsula experiences annually about 10 to 15 squalls within the speed range 60 to 100 km.p.h.

Grateful thanks are due to Shri P. Jaganathan, Meteorologist, Climatological Division, Poona-5, for critically going through the manuscript and offering valuable suggestions.



## LEAF DEVELOPMENT IN PALMS

D. PADMANABHAN

Department of Botany, Presidency College, Madras

THE plicate lamina of the palm leaf has been the subject of much interest since its ontogeny has been variously interpreted for the last hundred years and we are still far from a solution of the problem. Yampolsky (1922) has already summarized the early literature. Among the more recent works two opposed views have been advocated (Eames, 1953; Periasamy, 1962). According to Eames (1953) the plications develop initially as alternating ridges (produced by differential growth) and furrows on both surfaces of the laminal primordium. The ridges of one side oppose the furrows on the other. Subsequently, needle-shaped schizogenous splits originate in the interior of the lamina and extend towards the furrows on the opposite surface. Thus, the lamina is split up into folds (plications). No splitting occurs in the marginal portions (the 'reins') which bind the leaflets. According to Periasamy (1962), the plications originate due to the operation of an unusual type of meristematic activity in the laminal primordium and schizogenous splits do not occur. He interprets that meristematic activity is transferred from the marginal to the submarginal portions and the laminal meristem is divided into as many intercalary strips as there are plications. My own investigations confirm the occurrence of schizogenous splits in three species of palms—*Borassus flabellifer*, *Cocos nucifera* and *Phoenix sylvestris*.

The lamina is initiated by the marginal meristematic activity of the leaf primordium. This activity lasts only for a short period. The midrib (which becomes the rachis of the mature leaf) undergoes thickening due to the organization and activity of the adaxial and abaxial meristems (Padmanabhan, 1963). In particular, the widening of the insertion plane of the lamina occurs with the result that the laminal primordium also increases in thickness. At this stage the plications are initiated in the laminal primordium in a basipetal manner, except at its margins which form uniplicate strips of tissue (the 'reins' of Eames, 1953). It has been shown (Padmanabhan, 1963) that the plications originate due to the appearance of schizogenous splits on both surfaces of the laminal primordium (Figs. 1-3) at right angles to the midrib (rachis). The lines of splitting on the adaxial surface alternate with those on

the abaxial surface. The splits start right from the surface and progress inwards and stop short of the opposite surface (Figs. 1-4). The origin and deepening of the splits in the superficial layers results in the initiation of what have been called as 'ridges' and 'furrows' (Eames, 1953; Periasamy, 1962). As the splits on the adaxial and abaxial surfaces deepen a series of plications results (Fig. 4).

The description given above applies to *Borassus* and *Cocos*. *Phoenix* (Figs. 6-10) differs from *Borassus* and *Cocos* in that the adaxial splits do not involve the surface layers and occur deeper in the lamina (Fig. 7) thereby leaving a continuous sheet of laminal tissue on the adaxial side (Fig. 8) (see Padmanabhan, 1963 for details). This sheet which incorporates the primary veins of the lamina (Figs. 9, 10) has been interpreted by some authors (Goebel, Eichler, and Deinema; see Yampolsky, 1922) as a secondary product of the lamina—the 'Haut' or the 'Coiffe' (Fig. 10, H). As already pointed out by Yampolsky (1922) the haut is, in fact, a part of the lamina which is cast off when the leaflets unfold.

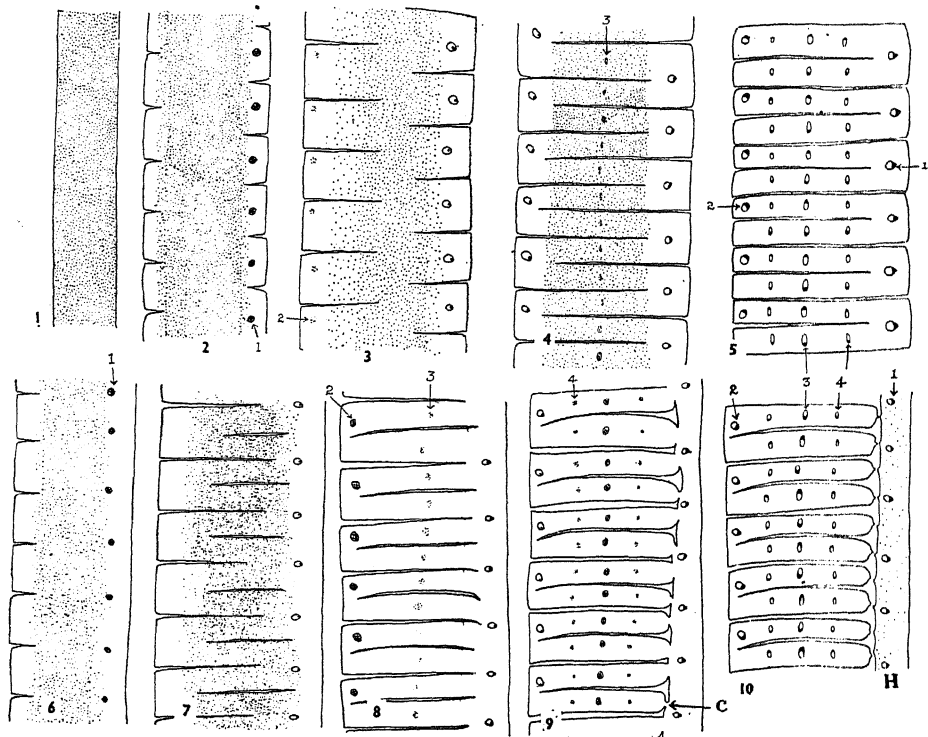
The plicate lamina further undergoes mechanical tearings (along the abaxial ridges, Fig. 5) which reach the rachis (*Cocos*, compound leaf with reduplicate leaflets) or stop midway between the margin and the rachis (*Borassus*, simple leaf). The extent of tearing varies among the species of the *Palmae* which exhibit diverse patterns of leaves. The rachis in *Cocos* elongates considerably thereby separating the leaflets. No marked elongation of the rachis and the consequent separation of the lamina into leaflets occurs in *Borassus*. In *Phoenix*, the leaflets are 'pinched off' from the continuous strip of adaxial tissue (haut) by the close approximation of the adaxial and abaxial splits near the haut (constriction, Fig. 9, C). The rachis elongates and separates the induplicate leaflets and the 'haut' breaks off when the leaf unfolds.

The lamina of the mature palm leaf shows a large number of parallel veins. There is a gradation in the size of veins correlated with the time of their origin. Commonly, the veins originate in succession, the larger ones differentiating earlier than the progressively smaller ones. Thus, among the early-formed veins four

categories may be distinguished tentatively as follows: the primaries, the secondaries (differentiating in between the primaries), the tertiaries (differentiating in between the secondaries and primaries) and the quaternaries. The veins differentiate in successive groups even while plications are being initiated (Figs. 2-5; 6-10). The primary veins occupy the adaxial ridges (Fig. 2) while the secondaries appear nearer to the abaxial ridges (Fig. 4). The tertiaries and quaternaries differentiate subsequent to the primary and secondary veins (Fig. 5). The primaries and secondaries anastomose in the marginal uniplicate strip (the 'reins') forming a marginal vein.

(1922). The cells of the lamina become progressively vacuolate from the *original surface* inwards (Figs. 1-4; 6-7). The surfaces of the leaflets are actually formed by the cells which originally occupy the interior of the unplicate lamina. This phenomenon which is peculiar to palms has been described by Eames (1953) but refuted by Periasamy (1962).

The 'haut' or 'coiffe' of *Phoenix* has been the subject of much discussion (see Yampolsky, 1922). One group of workers considered the 'haut' to be a product of the lamina mostly formed by the approximation of epidermal hairs (see Venkataanarayana, 1957). Yampolsky (1922) has already established with overwhelming



FIGS. 1-10. Sketches illustrating the ontogeny of palm leaf lamina. Sections cut at right angles to plications. Adaxial side shown towards the right in all figures. Densely staining areas stippled, the density of stippling is proportional to the intensity of meristematic activity. Numbers in figures represent primary (1), secondary (2), tertiary (3) and quaternary (4) veins. Figs. 1-5. Developmental sequence in *Borassus* and *Coccothrinax*. Fig. 1. Uniplicate laminal primordium. Fig. 2. Origin of primary veins and schizogenous splits (adaxial and abaxial). Figs. 6-10. Developmental sequence in *Phoenix*. Fig. 6. Origin of abaxial ridges. C—constriction; H—haut.

Histologically, the unplicate laminal primordium exhibits little internal differentiation excepting the delimitation of protoderm enclosing the inner mass of cells. Following the schizogenous splitting, the inner cells get exposed and a new protoderm is organized quickly as already recorded by Yampolsky

evidence from developmental studies that the 'haut' is a portion of the laminal tissue which is cast off when the leaf unfolds. The present investigation confirms this. The 'haut' in *Phoenix* is seen as a white sheet of parenchymatous tissue enclosing well-developed vascular tissues (the primary adaxial bundles, Fig. 10, H).

Among the palm species studied, two major categories seem to exist—species with leaves developing 'haut' (e.g., *Phoenix*, *Elais*, etc.) and those without 'haut' (e.g., *Borassus*, *Coccothrinax*, etc.).

The interpretation of the palm leaf—whether it is simple or compound—has been an interesting subject. Eames (1953) advanced the view that the palm leaf is simple in nature and the mechanism of leaflet formation is quite different from that in the compound leaf of dicotyledons. In the palm leaf, the leaflets are cut out of the lamina the margin of which is left unaffected holding the leaflets together until unfolding. The leaflets of palms do not have separate

initials nor do they exhibit apical or marginal growth typical of dicotyledonous leaves. The very existence of an exceptional type of development in palm leaves has been the cause of confusion in the literature.

I am indebted to Dr. K. Periasamy for kindly discussing his views and to Prof. B. G. L. Swamy for very kindly providing me with facilities.

1. Eames, A. J., *Phytomorphology*, 1953, **3**, 172.
2. Padmanabham, D., *Proc. Natl. Inst. Sci., India*, 1963 (In Press).
3. Periasamy, K., *Phytomorphology*, 1962, **12**, 54.
4. Venkatanarayana, G., *Ibid.*, 1957, **7**, 297.
5. Vampolsky, G., *Bull. Jard. Bot. Buitenzorg, Ser. 3*, 1922, **5**, 107.

## INDUCED SPHAEROCOCCOID MUTATIONS IN *TRITICUM AESTIVUM* AND THEIR PHYLOGENETIC AND BREEDING SIGNIFICANCE

M. S. SWAMINATHAN, D. JAGATHESAN AND V. L. CHOPRA

*Division of Botany, Indian Agricultural Research Institute, New Delhi*

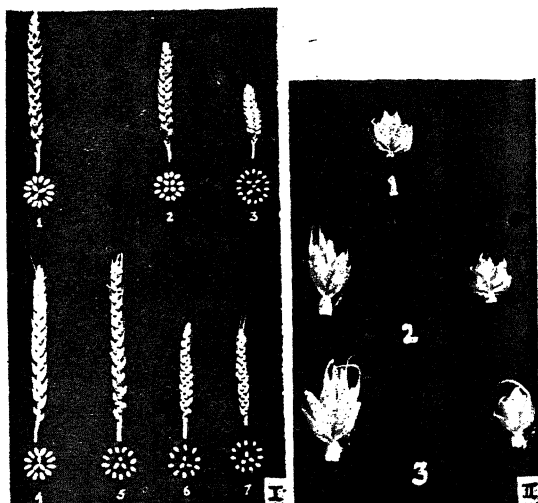
THE dwarf Indian wheats with dense ears and spherical grains, described by Howard and Howard<sup>1</sup> as varieties of *Triticum compactum* Host., were assigned specific status by Percival<sup>2</sup> and named *T. sphaerococcum*. *T. sphaerococcum* differs strikingly from the other hexaploid ( $2n = 42$ ) *Triticum* species in its rigid, erect and abruptly tapering leaves, small dense ears with inflated glumes and hemispherical grains. Its grains have been found in the excavations at Mohenjodaro in Sind.<sup>3</sup> In crosses between *T. aestivum* and *T. sphaerococcum*, the whole constellation of characters peculiar to the latter tends to be inherited as one recessive gene and hence Ellerton<sup>4</sup> postulated that *T. sphaerococcum* probably arose through the deletion of a chromosome segment in *T. aestivum*. Sears<sup>5</sup> showed that the *sphaerococcum* gene *S* is located on chromosome 3D (XVI). There has been considerable interest among wheat breeders in transferring the spherical grain character of *T. sphaerococcum* to the cultivated bread wheats since a round grain is ideal from the milling point of view.<sup>6</sup> Attempts in this direction have however not been successful.<sup>7</sup> The scope for isolating either spontaneous or induced mutants in *T. aestivum* possessing *sphaerococcoid* grains is hence worth exploring.

In the course of our studies on the frequency and spectrum of mutations occurring in the progenies of several varieties of *T. aestivum* sub-

jected to treatment with different physical and chemical mutagens, we have isolated two different types of *sphaerococcoid* mutants. A mutant having erect and rigid leaves, shorter stature and ears as compared to the control and inflated glumes and hemispherical grains was found in the  $M_2$  generation of the variety N.P. 799 treated with UV (1 hour) and 2.5  $\mu$ c. per seed of  $S^{35}$  (Figs. 1 and 2). This mutant is true breeding and possesses the rust resistance and other morphological traits of the parent strain. In crosses between the parent variety and the mutant, a single recessive factor was found to control the mutant phenotype. No segregation for the *sphaerococcoid* complex of characters occurred in the  $F_2$  progenies of reciprocal crosses between the mutant and *T. sphaerococcum*, thereby suggesting that this mutant has the same *S* gene as in *T. sphaerococcum*.

Another type of *sphaerococcoid* mutation giving rise to phenotypic characters resembling closely that of the mutant described recently by Schmidt and Johnson<sup>8</sup> occurred in six different varieties treated with different concentrations of ethyl methane sulphonate (EMS). The earliest to be recorded was in the  $M_2$  progeny of the strain H. 389 treated with 300 p.p.m. of EMS. This mutant had stiff and erect flag leaves with a cup-like ending, long and lax ears, hemispherical glumes and round grains.

The progenies of 2 such mutants contained 23 *sphaerococcoid* and 9 normal *aestivum* type plants. There was also segregation for ear density largely through the folding of the rachis in an "accordion" fashion (Fig. 1). This



FIGS. 1-2. Fig. 1. (1) Ear and grains of N.P. 799. (2) Ear and grains of *sphaerococcoid* mutant of N.P. 799. (3) Ear and grains of *T. sphaerococcum*. (4) Ear and grains of H. 389. (5, 6 and 7) Ears and grains of *sphaerococcoid* mutants of H. 389, showing different degrees of ear density. Fig. 2. (1) Spikelet of *T. sphaerococcum*. (2) Spikelets of control (left) and *sphaerococcoid* mutant (right) of N.P. 799. (3) Spikelets of control (left) and *sphaerococcoid* mutant (right) of H. 389.

mutant has been crossed with the parent strain as well as with *T. sphaerococcum*. Schmidt *et al.*<sup>9</sup> have found that the gene governing the *sphaerococcoid* characters in their mutant is incompletely dominant and is not allelic to the *sphaerococcum* gene.

The breeding behaviour of the *sphaerococcoid* mutants in H. 389 also suggests that the gene involved should have an incompletely dominant effect and cannot be a hemizygous ineffective one as is the case with the *S* locus of *T. sphaerococcum*.

The isolation of a *sphaerococcoid* mutant in *T. durum* by Schmidt and Johnson<sup>8</sup> suggests that a mutation in a A or B genome chromosome could also give rise to characters simulating the *S* gene effect in chromosome 3 D. The location of the gene responsible for the second type of *sphaerococcoid* mutant isolated by us is not yet known but it seems probable from the identity of this type both in phenotype and dominance relationship with that isolated and studied by Schmidt and Johnson<sup>8</sup> that the *S* locus in chromosome 3 D is not involved. The possibility of obtaining different types of *sphaerococcoid* mutations raises the hope that *T. aestivum* strains possessing round grains but not the other attendant characters like short and dense ear and stiff leaves as in *T. sphaerococcum* can be evolved. The recurrence of the second type of *sphaerococcoid* mutation in EMS-treated progenies of different varieties and its absence in other treatments suggests that this locus may be selectively affected by this mutagen.

The *sphaerococcoid* mutants obtained by us have high fertility and regular meiosis. The allelic identity of the N.P. 799 mutant with the *S* locus of *T. sphaerococcum* further strengthens the view that the latter species arose as a recessive mutation in *T. aestivum*. Its high drought tolerance appears to have been responsible for its preferential survival in North-Western Pakistan.

1. Howard, A. and Howard, G. I. C., *Wheat in India*, Calcutta, 1910.
2. Percival, J., *The Wheat Plant—A Monograph*, Duckworth, London, 1921, p. 463.
3. Marshall, J., *Mohenjodaro and the Indus Civilization*, London, 1931.
4. Ellerton, S., *J. Genet.*, 1939, **38**, 307.
5. Sears, E. R., *Genetics*, 1947, **32**, 102.
6. Newton, R. and Malloch, J. G., *Sci. Agric.*, 1925, **6**, 1.
7. Singh, R. D., *Ind. J. Genet.*, 1946, **6**, 34.
8. Schmidt, J. W. and Johnson, V. A., *Crop Science*, 1963, **3**, 98.
9. —, Weibel, D. E. and Johnson, V. A., *Ibid.* 1963, **3**, 261.

## LETTERS TO THE EDITOR

RECENT RESULTS ON ORBITAL  
CAPTURE

In 1958 Brysk and Rose<sup>1</sup> computed the theoretical L capture to K capture ratios. Most of the experimental measurements on L/K ratios have been in substantial agreement with theory. The large errors associated with these determinations did not provide a critical comparison with theory. In recent years the development of multiwire proportional counters<sup>2</sup> operated in conjunction with anti-coincidence grating circuitry together with the use of gaseous radioactive sources has made possible such a critical comparison. Precision results obtained with this technique are assembled in Table I and display a systematic deviation from the calculations of Brysk and Rose,<sup>1</sup> the experimental results being 5 to 10% larger than theoretical values. These deviations imply that some important factor is missing in the original calculation. This missing factor recently discovered by Bahcall<sup>3</sup> is the exchange term. The effect of exchange among the bound electrons that take part in the electron capture process leads to a correction of the form

$$\left( \frac{P_i}{P_e} \right) \left( \frac{\lambda_{1i}}{\lambda_K} \right) \left[ \frac{1}{2} \frac{2R_{1s}(O)/R_{2s}(O)}{1 - 2R_{2s}(O)/R_{1s}(O)} \langle 1S' | 2S \rangle \right]$$

where  $\lambda_{1i}/\lambda_K$  is the usual ratio as given by Brysk and Rose's theory.  $\langle 1S' | 2S \rangle$  is the overlap integral between the 1s electron in the daughter atom and a 2s electron in the parent atom and

$$\frac{R_{1s}(O)}{R_{2s}(O)}$$

the ratio of radial wave functions taken at the nuclear surface. Bahcall<sup>3</sup> has calculated the overlap integrals and the radial wave functions are given by Brysk and Rose.<sup>1</sup> In Table I are given the exchange correction. It is seen that agreement between theory (with exchange included) and experiment is excellent.

From Table I it is seen that as Z increases the discrepancy with Brysk and Rose's results is decreasing. It is not unlikely that negative deviations may occur for higher Z nuclei. It will be of great interest, therefore, to measure L/K ratio for a nucleus such as Cs<sup>131</sup> which decays by pure electron capture. Further, one may note that all reliable precision results have

TABLE I  
Comparison of L/K ratio with theory

Nuclide	Decay Energy (Kev)	Theoretical ratio due to Brysk and Rose	Exchange correction factor	Corrected theoretical ratio	Observed ratios	References
Ar <sup>37</sup>	815 ± 5	0.0820	1.22	0.100	0.102 ± 0.008 0.103 ± 0.003 0.102 ± 0.004 0.097 ± 0.001	1 2 3 4
Cr <sup>51</sup>	752 ± 5	0.0885	1.17	0.1034	0.1026 ± 0.0004	5
Mn <sup>54</sup>	545 ± 5	0.0899	1.16	0.1043	0.098 ± 0.006	6
Fe <sup>55</sup>	231 ± 2	0.0937	1.15	0.1078	0.106 ± 0.005 0.106 ± 0.003	6 7
Co <sup>57</sup>	730 ± 5	0.0916	1.14	0.1044	0.099 ± 0.011	6
Co <sup>58</sup>	1500 ± 20	0.0908	1.14	0.1035	0.107 ± 0.004	6
Zn <sup>65</sup>	234, 1347	0.0965	1.13	0.1090	0.119 ± 0.007	8
Ge <sup>71</sup>	231 ± 3	0.1032	1.12	0.1156	0.116 ± 0.005	9
Kr <sup>79</sup>	1620, 1372	0.102	1.09	0.111	0.1191 ± 0.001 0.108 ± 0.005	7 9

## Reference to Table I

1. Kiser, R. W. and Johnson, W. H., *J. Am. Chem. Soc.*, 1959, **81**, 1810.
2. Santos-Ocuampo, A. G. and Conway, D. C., *Phys. Rev.*, 1960, **130**, 2196.
3. Dougan, P. W., Ledingham, K. W. D. and Drever, R. W. P., *Phil. Mag.*, 1962, **7**, 475.
4. Manduchi, C. and Zannoni, G., *Nuovo Cimento*, 1961, **22**, 462.
5. Fasoli, V., Manduchi, C. and Zannoni, G., *Ibid.*, 1962, **23**, 1126.
6. Moler, R. B. and Fink, R. W., *Phys. Rev.*, 1963, **131**, 821.
7. Manduchi, C. and Zannoni, G., *Nucl. Phys.*, 1962, **36**, 497.
8. Santos-Ocuampo, A. G. and Conway, D. C., *Phys. Rev.*, 1962, **128**, 258.
9. Drever, R. W. P. and Molijk, A., Private Communication, see Reference 6.

come from one technique only, namely the multiwire proportional counter. It will be very helpful if alternative techniques are developed which can yield results of comparable precision. Then one can eliminate a possible systematic error in the multiwire counter technique.

On the theoretical side it may be worthwhile to re-examine Brysk and Rose's theory to see if any refinements can be made without the inclusion of the Bahcall exchange effect. It seems, however, unlikely that any refinement will yield a correction as large as the exchange term. Further one would expect that the exchange effect will be more important for M/L ratio. Unfortunately, precision measurements of

this quantity are beset with considerable experimental difficulties.

There is no doubt that further data will put the exchange effect on a sound basis.

Department of Physics, M. K. RAMASWAMY,  
Karnatak University,  
Dharwar-3, October, 1, 1963.

1. Brysk, H. and Rose, M. E., *Revs. Modern Phys.*, 1958, **30**, 1169.
2. See the Review Article by Robinson, B. L. and Fink, R. W., *Ibid.*, 1960, **32**, 117.
3. Bechall, J. N., *Phys. Rev. Letters*, 1962, **9**, 500.

### GROWTH SPIRALS AND CLOSED-LOOP PATTERNS ON ZINC SINGLE CRYSTALS

SPIRALS and closed-loop patterns have been reported on many crystals. Among the early observations which have lent support to Frank's theory of spiral growth are those reported by Griffin,<sup>1</sup> Verma,<sup>2</sup> Forty<sup>3</sup> and others. So far no growth spirals have been reported on zinc crystal. However, George<sup>4</sup> has reported spirals revealed by etching zinc crystals grown from vapour. The present communication is the

on the free surface of crystals grown from melt.

The crystals were grown by Bridgman's technique in a vertical gradient furnace using metal of 99.995% purity at a fast rate of about 6-8 cm./hr. In the absence of insoluble and oxidised impurities the free surface of the crystal develops a number of flat facets of high reflectivity.

On examining these facets many interesting features were observed. A hexagonal spiral is shown in Fig. 1, and Fig. 2 is a micrograph showing a closed-loop with a light profile running across it. A large number of such loops have been observed and analysed. While the spiral in Fig. 1 is of low step height, the light profile in Fig. 2 shows that the closed-loop features have large step-heights of the order of a micron. While the loop patterns can result from a growth mechanism analogous to the Frank-Read source, the observed large step-heights cannot be explained by this mechanism without assuming large Burger's vector for the dislocations. However if one assumes two alternatively active double spiral mechanism the observed large step-height can

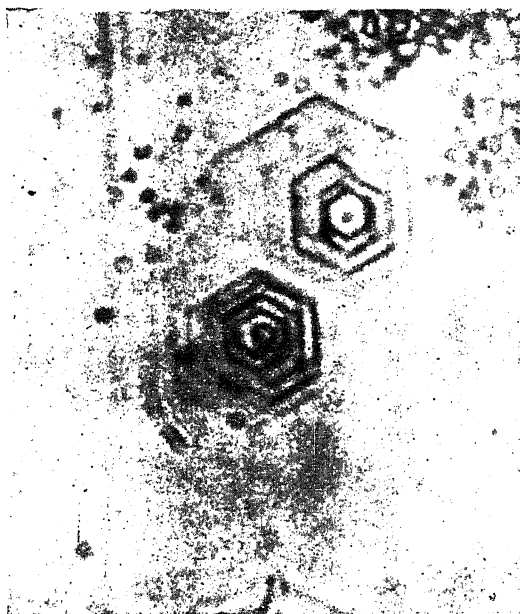


FIG. 1,  $\times 960$

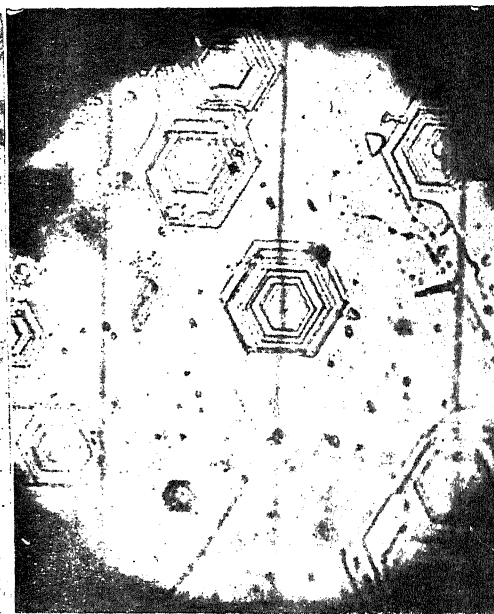


FIG. 2,  $\times 480$

preliminary report of the spirals and loop patterns observed on the facets of the zinc crystals grown from melt. These patterns are unique in the sense they have been observed

be explained. Such a mechanism has been used by Henschke<sup>5</sup> to explain the unique closed-loop patterns observed on the micro-blisters of copper films sputtered on to a glass substrate.

Since metals can be supercooled far below their melting point it is more likely that they grow by surface nucleation, than by the dislocation mechanism. The flat facets are developed due to large supercooling and high purity of metals. While sealing the crystal mould it is customary to leave some space above the metal. During the growth of crystals in the furnace the metal vaporises into this space. These vapours can deposit on the facets subsequent to their development and result in the observed pattern. Thus the pattern is the result of the growth from the vapour phase and not from the melt.

Physics Department, N. S. PANDYA.  
M.S. University, A. P. BALASUBRAMANIAN.  
Baroda, October 3, 1963.

1. Griffin, B., *Phil. Mag.*, 1950, **41**, 196.
2. Verma, A. R., *Ibid.*, 1951, **42**, 1005.
3. Forty, A. I. and Frick, E. C., *Proc. Roy. Soc. (Lon.)*, 1953, **217**, 262.
4. George, L., *Phil. Mag.*, 1959, **4**, 1142.
5. Henselke, E. B., *J. Appl. Phys.*, 1958, **29**, 1495.

### MAGNETIC BEHAVIOUR OF RARE-EARTH IONS IN STATE OF SOLUTION

In crystalline salts of the rare-earth ions the crystal field, responsible for the deviation from their ideal free ion magnetic behaviour, arises generally from: (a) the contributions of the neighbouring point charges of both rare-earth and ligand ions and the induced and the quadrupole moments of ligand ions only, (b) the contributions from the induced moments due to the distortions of the 5s- and 5p-spherically symmetric closed shells of electrons, and (c) the shielding and antishielding effect of these distorted orbitals.

crystals of  $\text{PrCl}_3$  and  $\text{PrBr}_3$  show that the field parameter,  $A_2^0$ , is reduced by 52% when distortions of 5p- and 5s-orbitals are taken into account bringing the  $A_2^0$  ( $r_2$ ) value much closer to the experimental value.

This implies that with distortions the effect of the crystal field on rare-earth ion is weaker than that without distortions. Consequently the magnetic moment will be larger in crystalline state than that in state of solution. For, in state of solution the lattice structure breaks down giving rise to an average spherical symmetry of the surrounding charges and hence distortions of 5s- and 5p-orbitals will be less. With the increase of dilution the distortions will decrease making the effect of the field stronger.

Our very accurate measurements of the magnetic moment ( $\mu$ ) of the available rare-earth ions of spectroscopic purity by a sensitive microbalance<sup>2</sup> using the procedure of Mookherji<sup>3</sup> revealed that moment values in state of solution are always less than those in the crystalline state. This is shown in Table I.

Judd<sup>9</sup> found that the crystal field in state of solution had to be made a bit stronger than the crystalline state in order to fit the optical data of the rare-earth ions in state of solution. This is in close agreement with our findings.

Octahydrated sulphates were used for measurements in state of solution as the magnetic moment values in crystals for these were available. These are very sparingly soluble in water. As a result the rare-earth ions will be removed considerably from each other's influence reducing the distortions on 5s- and 5p-orbitals even at the highest concentration that could be used for measurement. Naturally further dilution will have no effect on moment values. This has been observed.

Details will be published elsewhere.

TABLE I

Ions	Ce	Pr	Nd	Temperature: 300° K.		Gd	Tb	Dy	Ho	Er	Yb
				Sm	Eu						
$\mu$ (solution)	2.309	3.355	3.398	1.348	3.157	7.786	9.446	10.337	10.344	9.317	4.247
$\mu$ (crystal)	3.007 <sup>a</sup>	3.482 <sup>a</sup>	3.516 <sup>a</sup>	1.674 <sup>b</sup>	3.278 <sup>a</sup>	7.810 <sup>a</sup>	9.600 <sup>a</sup>	10.460 <sup>b</sup>	10.500 <sup>a</sup>	9.435 <sup>b</sup>	4.538 <sup>c</sup>

The effects, (a) and (b), are due to the influence of the rare-earth orbitals of one ion on the crystal field at another ion, whereas (c) is due to the effect of the same ion.

In a recent paper Ray<sup>1</sup> has shown that the effect due to (a) is not important for crystal field parameters, but (b) has great influence on them. His calculations with  $\text{Pr}^{3+}$  ion in the

Physics Laboratory,  
University of Burdwan,  
Burdwan, October 22, 1963.

A. MOOKHERJI.  
T. MOOKHERJI.

1. Ray, D. K., *Proc. Phys. Soc.*, 1963, **82**, 47.
2. Neogy, D. and Lal, R. B., *Sci. Indus. Res.*, 1962, **21 B**, 10<sup>1</sup>.
3. Mookherji, T., *Ind. Jour. Phys.*, 1962, **36**, 215.

4. Mathur, S. C., *Thesis, Agra University, Agra*, 1961.
5. Mookherji, A., *Ind. Jour. Phys.*, 1949, **23**, 309.  
— *Ibid.*, 1949, **23**, 410.  
— *Ibid.*, 1949 **23**, 445.
6. Neogy, D., *Thesis, Agra University, Agra*, 1961.
7. Mookherji, A. and Neogy, D., *Ind. Jour. Phys.*, 1962, **36**, 107.
8. Van Vleck, J. H., *Theory of Electric and Magnetic Susceptibilities*, Oxford University Press.
9. Judd, B. R., *Phys. Rev.*, 1962, **127**, 750.

### STUDIES IN REACTIONS OF BORON TRIFLUORIDE

THE preparation and structures of Metal Cyanide Lewis acid bridge compounds have been discussed by Shriver.<sup>1,2</sup> Representative compounds prepared by him include  $K_2Ni(CN)_4 \cdot 4BF_3$ ,  $K_4Fe(CN)_6 \cdot 6BF_3$ ,  $K_3Mo(CN)_3 \cdot 8BF_3$  and  $Fe(phen)_2(CN)_2 \cdot 2BF_3$ . Investigations of the reactions of boron trifluoride with almost similar types of compounds were carried out in this Institute Laboratories in 1960.<sup>3</sup> However, the experimental conditions and the resultant products in these investigations appear to be different from those reported by Shriver.

$K_4Fe(CN)_6$  was subjected to a stream of  $BF_3$  and the temperature raised gradually. The range of temperatures used in the reaction varied between 200°–320°. The resultant product was very deep blue with a bronzy lustre. It was found to be comparatively stable in the absence of moisture. The original cyanide increased in weight on absorption of  $BF_3$ . The product was analysed to determine the percentage of Fe and N. The results of these determinations corresponded to a product with the formula  $2K_4Fe(CN)_6 \cdot 3BF_3$ . It was found that a compound having this formula was formed within an optimum temperature range only.

Magnetic susceptibility measurements of the reaction products showed that they were highly paramagnetic. This was an indication that a profound change had occurred, since  $K_4Fe(CN)_6$  is originally diamagnetic. The magnetic susceptibility was also observed to rise with the temperature and then fall, after reaching a maximum value, with a further rise in temperature. This peak value was observed in the maximum temperature range for the formation of the product.

X-ray spectrometric studies indicated the reaction product was non-crystalline, almost amorphous. Comparison with the known spectrochemical data on the ASTM card index showed that the compound had no similarity to any known compound listed on the card index file. Comparison of the X-ray patterns of the

reaction products with those of  $K_4Fe(CN)_6$ , as a standard, indicated that the original complex cyanide structure had apparently collapsed completely, yielding place to the characteristically weak patterns of the new product. No superimposition of peaks was found, showing that the original complex cyanide no longer retained its structure. The analytical data, magnetic susceptibility measurements and X-ray diffraction investigations all support the formation of a new stoichiometric adduct between  $K_4Fe(CN)_6$  and  $BF_3$  with the composition  $2K_4Fe(CN)_6 \cdot 3BF_3$ .

Reactions on almost similar lines were carried out between  $K_3Fe(CN)_6$ ,  $Na_2[Fe(CN)_5NO]$ ,  $K_3Mn(CN)_6$ ,  $K_3Cr(CN)_6$  and  $BF_3$ . Details of the experimental procedures, analytical data, magnetic susceptibility measurements, and X-ray diffraction studies will be published together with the results of the reactions of  $BF_3$  with several other organo-metallic compounds, in subsequent publications.

Department of Chemistry,  
Institute of Science,  
Bombay-1, October 10, 1963.

S. M. MEHTA.  
V. K. KABIR.

1. Shriver, D. F., *J. Am. Chem. Soc.*, 1962, **84**, 4610.
2. —, *Ibid.*, 1963, **85**, 1405.
3. Kabir, V. K., *Ph.D. Thesis*, Bombay University, 1960.

### CHEMICAL EXTRACTIVES OF THE HEARTWOOD OF *SHOREA ROBUSTA*

EXTRACTION of thin shavings of the heartwood of *Shorea robusta* using petroleum ether or benzene removed the acid and waxy impurities and subsequent extraction with acetone gave (a) a neutral compound, m.p. 90–92°; (b) a terpene alcohol, m.p. 156–58°; (c) two triterpenes, m.p. 304–06° and 327–29°; and (d) a leucoanthocyanidin, m.p. 280° (d.).

The leucoanthocyanidin (d.) had the molecular formula,  $C_{15}H_{14}O_7$ , 2  $H_2O$  dextro-rotatory, and formed a hexaacetate, m.p. 270–72°, a trimethyl ether, m.p. 198–200° and a diacetate of the trimethyl ether, m.p. 240–41°. Boiling with dilute hydrochloric acid gave cyanidin chloride, while oxidation of the methyl ether with potassium permanganate and sodium metaperiodate gave veratric acid and veratric aldehyde and di-O-methyl phloroglucinaldehyde respectively. These experimental results led us to the conclusion that the leucoanthocyanidin is (+)-5, 7, 3', 4'-tetrahydroxy-flavan-3, 4-diol, and possibly



identical with the leucocyanidin isolated from *Butea frondosa* gum.<sup>1</sup>

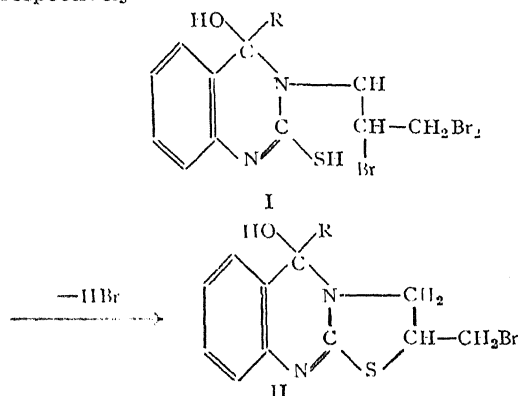
Compounds (c) gave the following reactions. They are both dextro-rotatory and dissolved readily in alkalis and alkali carbonates and the solutions that were originally colourless developed an orange red colour on standing, and gave no colour with alcoholic ferric chloride. They gave the following colour reactions: (1) Liebermann-Burchard—yellow—orange red—red brown, (2) Salkowski reaction—yellow—orange red, (3) Zimmermann reaction—red, (4) Tetranitromethane reaction—yellow, (5) Noller's reagent—orange red—deep red—purple, (6) Tschugaeff test—deep orange red, and (7) Rosenheim reaction—red—deep red. On boiling with dilute acids, they changed their colour to green and exhibited an intense blue or bluish-violet fluorescence in solutions while the solutions were coloured pale yellow. Analytical results indicated a molecular formula,  $C_{30}H_{48}O_6$ ,  $H_2O$  and a rotation value  $[\alpha]_D^{20} + 55$  (c, 1.25 in pyridine), and gave a methyl ester with diazomethane, m.p. 223–25°,  $[\alpha]_D^{20} + 55$  (c, 1.20 in methanol, and an acetate of the methyl ester, m.p. 176–78° and a triacetate, m.p. 193–200°). The ultra-violet absorption spectrum of the methyl ester showed "end absorption" typical of a trisubstituted double bond and was shown to contain a 1,2-glycol system by its reaction with lead tetra-acetate. From these results and a comparison of the constants of the ester and the corresponding acid with those of methyl acetate and acetic acid, it appeared likely that the two compounds are identical. Although the two triterpenoids have different melting points, we consider it likely that they are both the same, acetic acid.

The nature of the other constituents is still in progress. Fuller details would be published elsewhere.

Dept. of Chemistry, CH. BHEEMASANKARA RAO.  
Andhar University, T. V. PADMANABHA RAO.  
Waltair, V. VENKATESWARLU.  
October 22, 1963.

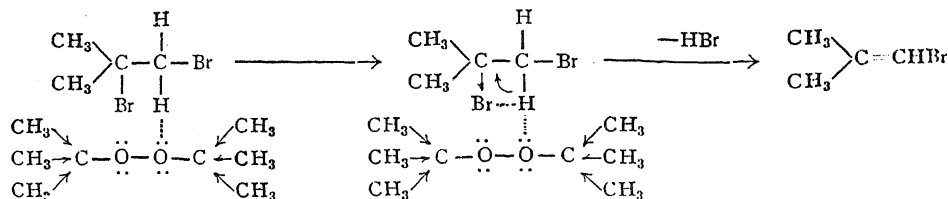
## PEROXIDES AS DEHYDROHALOGENATING AGENTS

NARANG and coworkers observed that benzoyl peroxide facilitates dehydrobromination of 1:2-dibromo isobutane<sup>1</sup> to isobutenyl bromide and that hydrogen peroxide helps the cyclisation of 2-mercapto-3-(2':3'-dibromopropyl)-4-carbethoxy-4-hydroxyl dihydroquinazoline (I,  $R = -COO C_2H_5$ ) and 2-mercapto-3-(2':3'-dibromopropyl)-4-hydroxyl dihydroquinazoline (I,  $R = H$ ) through dehydrobromination with sodium hydroxide to yield 2-bromomethyl-4-carbethoxy-4-hydroxyl-10:11-thiopega-9-ene (II,  $R = -COO C_2H_5$ ) and 2-bromomethyl-4-hydroxyl-10:11-thiopega-9-ene (II,  $R = H$ ) respectively.<sup>2</sup>



In the dehydrobromination of 1:2-dibromo isobutane, with alcoholic KOH, it has now been found that tertiary butyl peroxide functions as a better catalyst than benzoyl peroxide and also that organic compounds containing ethereal oxygen like dioxan also catalyse dehydrobromination. The percentage yields of isobutenyl bromide obtained by using tertiary butyl peroxide, benzoyl peroxide and dioxan were 62, 50 and 50% respectively as against 27% when no catalyst was employed and the reaction mixture was refluxed, for 7 hours. These experiments with tertiary butyl peroxide, benzoyl peroxide and dioxan were performed by heating in ethanolic potassium hydroxide solution for one hour only. This observation, viz., the superiority of tertiary butyl peroxide over that of benzoyl peroxide and dioxan in dehydrobromination leads to the conclusion that the function of these reagents is associated with the electron richness of oxygen as out of these reagents, it will be maximum in the case of tertiary butyl peroxide. A probable mechanism of the role of tertiary butyl peroxide in dehydrobromination would be:

1. Ganguly, A. K. and Seshadri, T. R., *Tetrahedron*, 1959, **6**, 21.
2. Holteau, P., Buzas, A., Lederer, E. and Polonsky, J., *Nature*, 1949, **163**, 258.  
Polonsky, J., *Bull. Soc. chim. Fran c.*, 1953, p. 173.  
Djerassi, C., Thomas, D. B., Livingston, A. L. and Thompson, C. R., *J. Amer. Chem. Soc.*, 1957, **79**, 5292.



Department of Chemistry, HARJIT SINGH.  
Panjab University, B. K. P. S. SHANT.  
Chandigarh-3, K. S. NARANG.  
October 22, 1963.

1. Ralhan, N. K., Gurdial Singh and Narang, K. S., *J. Sci. Ind. Res.*, 1960, **19 B**, 505.
2. Sharma, G. M., Soni, K. K. and Narang, K. S., *Tetrahedron*, 1962, **18**, 1019.

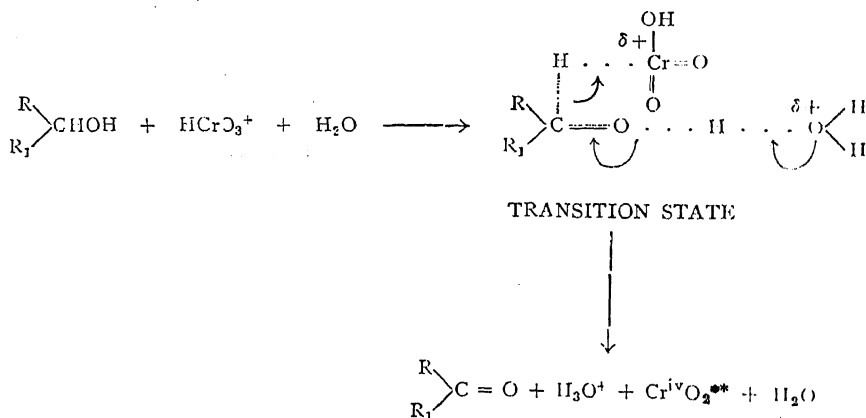
### AN 'E<sub>2</sub>' MECHANISM FOR THE CHROMIC ACID OXIDATION OF SECONDARY ALCOHOLS

VARIOUS mechanisms have been postulated for the oxidation of secondary alcohols by chromic acid. All of them are agreed on the basis that the rate-determining step of the oxidation process involves the rupture of the C—H bond—an inference drawn from the study of the kinetic isotopic effect.<sup>1</sup> Westheimer's mechanism<sup>2</sup> for the oxidation process involves the loss of the

on the basis of the mechanism postulated by one of us<sup>6,7</sup> for the oxidation of aromatic aldehydes.

While the topology of the transition state allows participation by water at the carbonyl carbon in aldehyde oxidation, it is difficult to visualize the same type of attack with secondary alcohols. There is no polarisation possible here as in the carbonyl bond of the aldehyde. Further, it is also difficult to understand an external molecule of water attacking the carbon, inasmuch as the lone pair of electrons on the oxygen of the OH bonded to the carbon would more easily participate in the transition state to "push off" the hydride anion in a concerted process. Also, the attack by a molecule of water on the highly shielded carbon, when a much less shielded hydrogen is available at the OH group, appears unlikely.

We envisage, therefore, the following mechanism simulating the familiar 'E<sub>2</sub>' processes for the reaction course:



\*\* (Note added in proof): "This is an intermediate postulated in the reduction of Cr (vi) to Cr (iii)."

hydrogen of the C—H bond as a proton, while the loss of the same hydrogen as a hydride anion has been postulated by Roček and Krupička<sup>3</sup> and by Anantakrishnan and Venkatasubramanian.<sup>4</sup>

Recently, Venkatasubramanian<sup>5</sup>—formerly of these laboratories—put forward a mechanism for the oxidation simulating the 'S<sub>N</sub>2' mechanism,

This mechanism has the advantage of accounting for the more possible attack by the water molecule on the hydrogen atom of the unshielded OH group, than in the well-protected carbon nucleus.<sup>8</sup> Further, the above transition state with dispersal of the positive charges accounts well for the fact that the reaction rate decreases with increasing dielectric constant, brought about by increasing amounts of water,

which disturbs the transition state and thus lowers the reaction rate.<sup>9</sup>

A reaction which proceeds through such an activated complex should follow  $H_0$ .<sup>10</sup> Roček<sup>11</sup> has shown that the chromic acid oxidation of isopropyl alcohol follows  $H_0$  in strong  $H_2SO_4$ . It is very likely that such a linear relationship would hold good in the studies of Venkatasubramanian also.

The authors express their gratitude to Professor S. V. Anantakrishnan for the valuable discussions. Thanks are due to the Council of Scientific and Industrial Research for the award of a Senior Research Fellowship to one of us (H. J.).

Dept. of Chemistry, P. S. RADHAKRISHNAMURTI,  
Madras Christian H. JAYARAMAN.

College, Tambaram,  
Madras-45, November 6, 1963.

1. Westheimer, F. H. and Nicolaidis, *J. Amer. Chem. Soc.*, 1949, **71**, 25.
2. — and Cohen, *Ibid.*, 1952, **74**, 4387.
3. Roček, I. and Kropicka, J., *Coll. Czech. Chem. Comm.*, 1958, **23**, 2068.
4. Anantakrishnan, S. V. and Venkatasubramanian, N., *Proc. Ind. Acad. Sci.*, 1960, **51**, 310.
5. Venkatasubramanian, N., *Indian J. Chem.*, 1963, **1**, 48.
6. Jayaraman, H., *Ph.D. Thesis* submitted to the University of Madras, August 1962, p. 115.
7. Anantakrishnan, S. V. and Jayaraman, H., *Proc. Ind. Acad. Sci.* (in Press).
8. Ingold, C. K. *Structure and Mechanism in Organic Chemistry*, Cornell, 1953, p. 451.
9. Hughes, E. D. and Ingold, C. K., *Trans. Faraday Soc.*, 1941, **37**, 657.
10. Zucker, L. and Hammett, L. P., *J. Amer. Chem. Soc.*, 1939, **61**, 2779.
11. Roček, I., *J. Coll. Trans. chim. Tchecosl.*, 1958, **23**, 2068.

## DIRECT SULPHONATION OF QUINAZOLINONES

Although nitration of 3,4-dihydroquinazolin-4-one and 2-methyl-3,4-dihydroquinazolin-4-one is known<sup>1</sup> to yield their corresponding 6-nitro derivatives, there are no reports of sulphonation studies on the quinazolin-4-one system up-to-date. During the course of our studies on diuretics, the investigation of direct sulphonation of 3,4-dihydroquinazolin-4-one and its derivatives was undertaken. It has been found that with oleum or chlorosulphonic acid, position 6 in 2-alkyl (or H)-3,4-dihydroquinazolin-4-one gets substituted with sulpho or chlorosulphonyl group respectively. If position 7 carries a substituent, like chlorine, both oleum and chlorosulphonic acid give rise to only

6-sulpho derivatives of quinazolinone. The latter 6-sulpho derivatives are, however, converted to the corresponding chlorosulphonyl derivatives with thionyl chloride and chlorosulphonic acid. In this investigation, all the chlorosulphonyl derivatives are converted to the corresponding sulphamyl derivatives with ammonia and characterized.

**6-Sulphamyl-3, 4-dihydroquinazolin-4-one.**—To 3,4-dihydroquinazolin-4-one (0.1 mole), cooled in ice, was added chlorosulphonic acid (0.3 mole); the reaction mixture was gradually heated to 140° and held at that temperature for three hours. The viscous, brown reaction product was cooled and poured into crushed ice (300 g.) to obtain 6-chlorosulphonyl-3,4-dihydroquinazolin-4-one as an off-white solid. The chlorosulphonyl derivative was allowed to react with ammonia (200 ml.); the product went into solution on stirring; the ammoniacal solution was charcoaled, boiled and filtered; the filtrate on acidification to pH 3 gave 6-sulphamyl-3,4-dihydroquinazolin-4-one melting at 210° to 215° C. in 56% yield. It was purified by dissolving in alkali, filtering and acidifying with acetic acid; m.p. 217–20°. Found: N, 17.4; Calc. for  $C_8H_9N_3O_3S$ :  $H_2O$ : N, 17.2%.

**2-Methyl-6-sulphamyl-3, 4-dihydroquinazolin-4-one.**—This was prepared starting from 2-methyl-3,4-dihydroquinazolin-4-one as in the above example; m.p. > 320°. Found: N, 17.2; Calc. for  $C_9H_{10}N_3O_3S$ : N, 17.4%.

**7-Chloro-6-sulpho-3, 4-dihydroquinazolin-4-one.**—To 7-chloro-3,4-dihydroquinazolin-4-one (4 g.) and mercuric oxide (0.4 g.) was added oleum (10% ; 20 ml.) and heated at 160–80° for 10 hours. The resulting dark-brown solution was cooled to room temperature and poured into crushed ice (200 g.) when 7-chloro-6-sulpho-3,4-dihydroquinazolin-4-one separated out gradually as an off-white powder. It was purified by dissolving in ammonia, charcoaling, filtering and acidifying with hydrochloric acid; m.p. > 320°. Found: N, 10.8; Calc. for  $C_8H_7ClN_3O_4S$ : N, 10.7%.

**7-Chloro-6-sulphamyl-3, 4-dihydroquinazolin-4-one.**—To 7-chloro-3,4-dihydroquinazolin-4-one (0.02 mole) and sodium chloride (0.1 mole) was added chlorosulphonic acid (0.11 mole) dropwise. The reaction mixture was then heated at 130° for five hours. The product was cooled to room temperature and added into crushed ice (100 g.). A solid was obtained which, on purification, proved to be the starting material; from the filtrate, on boiling and cooling, was obtained a colourless solid (1 g.) which was identified

as 7-chloro-6-sulpho-3, 4-dihydroquinazolin-4-one. The 6-sulpho derivative was then refluxed with chlorosulphonic acid (10 ml.) and thionyl chloride (12 ml.) for five hours. The product was cooled and poured into ice (200 g.) when 7-chloro-6-chlorosulphonyl-3, 4-dihydroquinazolin-4-one was obtained as a solid. The chlorosulphonyl derivative was allowed to react with ammonia (30 ml.); the resulting solution was boiled, charcoaled, filtered and acidified with acetic acid to obtain 7-chloro-6-sulphamyl-3, 4-dihydroquinazolin-4-one as an off-white solid melting at  $318^{\circ}$  (reported<sup>2</sup> m.p.  $310-15^{\circ}$ ). Found: N, 16.0; Calc. for  $C_8H_6ClN_3O_3S$ : N, 16.2%.

Research and Development S. SOMASEKHARA.  
Division, S. L. MUKHERJEE.  
Sarabai Chemicals,  
Baroda, October 10, 1963.

1. Elderfield, R. C., *Heterocyclic Compounds*, John Wiley & Sons, 1957, **6**, 353.
2. Cohen, E., Klarberg, B. and Vaughan, Jr., J. R., *J. Am. Chem. Soc.*, 1960, **82**, 2731.

#### AMINO-ACIDS IN ARECA CATECHU LINN. (N.O. PALMAE)

THE nuts of *Areca catechu* are commonly used as a masticatory in India and other South-east Asian countries. Their protein, fat, carbohydrate and tannin contents have been recorded.<sup>1</sup> This communication deals with the qualitative and quantitative analysis of the amino-acid make-up of *A. catechu*.

The ripe nuts about eight months old and semi-ripe nuts six to seven months old were obtained from a plantation in Kerala. The fruit, after the removal of the *epicarp*, was dried below  $60^{\circ}\text{C}$ . in shade and powdered to 60 mesh. Five gm. of the powdered nut was shaken with 50 ml. of water for 3 hours in a mechanical shaker. The material was then centrifuged and the supernatant taken in a conical flask. The residue was washed three or four times with distilled water till the washing gave no colour with ninhydrin. All the washings together with the first supernatant were mixed and evaporated to dryness over a water-bath. The material obtained was taken up in 10% isopropanol and used for analysis of the free amino-acids.

The powdered nut was hydrolysed by refluxing the material with required quantity of 6N HCl for 20 hours.<sup>2</sup> An alkaline hydrolysate was also prepared for the detection of tryptophan<sup>2</sup> which is destroyed by acid hydrolysis.

The nitrogen content of the extracts was determined by the micro-kjeldahl's method.<sup>3</sup>

For qualitative analysis, the amino-acids were separated by using the descending, two-dimensional and circular paper chromatographic technique. Circular paper chromatography with four different solvent systems<sup>4</sup> was adopted for quantitative study.  $\alpha$ -amino butyric acid was estimated by two-dimensional chromatography.

Whatman No. 1 filter-papers, 44 cm. square, were used for circular paper chromatography and  $46 \times 56$  cm. filter-paper for two-dimensional chromatography. The papers were washed with N/100 HCl and then thrice with distilled water prior to use.

Amino-acids were identified by spraying the chromatograms with 0.4% ninhydrin in acetone and developing the colour by warming to  $60^{\circ}\text{C}$ . for 10 mts. and also by spraying Folin's reagent. Proline was identified by blue colour reaction with isatin and estimated by using sodium 1:2 naphtha-quinone-4-sulphonate reagent.<sup>5</sup> Confirmation was obtained by running the authentic samples of amino-acids along with the test materials and also by specific tests like isatin test, Folin's test, Panly's reagent, etc., for particular amino-acids. Test for the presence of non- $\alpha$ -amino-acids were also carried out according to Crumpler and Dent.<sup>6</sup>

The results are tabulated in Table I. The arecanuts contain a large number of amino-acids both in free and combined state. The changes which occur successively on maturity are of physiological interest and of biochemical importance in the nitrogen metabolism of the plant. The distinguishing features of the amino-acid make-up of arecanut appears to be: absence or insignificant quantity of tryptophan and methionine; presence of high percentage of proline in both free and combined forms in semi-ripe and ripe state; a relative increase of free tyrosine and phenyl alanine and of combined arginine in the semi-ripe and ripe nuts.

Besides the amino-acids mentioned above, the two-dimensional chromatography of the acid hydrolysate of the ripe and semi-ripe nut has revealed three ninhydrin positive spots which need identification.

The protein nitrogen of the nuts remains more or less constant while the non-protein nitrogen is found to decrease with maturity.

Because of the relative specificity of nitrogen metabolism, the amino-acid composition has recently been viewed as a means of identifying the species of the plant and also as a means for detecting adulteration of plant products.

TABLE I

Amino-acid composition of Areca catechu nuts

Amino-acids	Free amino-acids (water extract)		Combined amino-acids (hydrolysate)	
	S. Kipe	Ripe	S. Ripe	Ripe
1 Cystine	.. ++	++	++	++
2 Lysine	.. +	+	++	+
3 Histidine	.. +	+	++	++
4 Arginine	.. +	+	+++	+++
5 Alanine	.. +	+	++	+
6 Tyrosine	.. +++	+++	+	+
7 Ph. alanine	.. +++	+++	+	+
8 Asp. acid	.. +	+	+	++
9 Glut. acid	.. ++	++	+	+++
10 Serine	.. +	+	+	++
11 Glycine	.. ++	+	+	+
12 Threonine	.. ++	+	+	+
13 Valine	.. +	++	++	+
14 Leucine	.. +	+	+	+
15 Iso-leucine	.. +	+	+	+
16 Prolin	++++	++++	++++	++++
17 $\alpha$ -Amino butyric acid y	++	+	+	++
Total amino-acids mgm./gm. dry wt.	6.56	6.02	27.73	26.99

Notation:—When the specified amino-acid represents less than 5% of total amino-acid = +, 5 to 10% = ++, 10 to 15% = +++ and above 15% = ++++.

With this object in view a detailed study of arecanut grown in other regions of India and of the wild arecanut is in progress and will be reported separately.

Our thanks are due to Mr. V. S. Govindarajan, C.F.T.R.I., Mysore, for providing the arecanuts. One of the authors (H. L. K.) is grateful to the UNICHEM Laboratories, Bombay, for the award of a fellowship.

Pharmacology Lab., Miss H. LALITHA KUMARI.  
Indian Inst. of Sci., M. SIRSI.  
Bangalore-12, May 16, 1963.

1. Raghavan, V. and Baruah, H. K., *Sci. and Cult.*, 1956, 22, 150.
2. Block, R. J., Durrum, E. L. and Zweig, G., *A Manual of Paper Chromatography and Paper Electrophoresis*, Academic Press, 1958.
3. Hawk, P. B., *Practical Physiological Chemistry*, Twelfth Edition, The Blakiston Company, Toronto, 1947.
4. Ravindranath, Hanumantha Rao, K. and Giri, K. V., *Jour. Sci. and Indus. Res.*, 1957, 16 C, 228.
5. Nagabushanam, A. and Giri, K. V., *Naturwissenschaften*, 1952, 39, 548.
6. Crumpler, H. R. and Dent, C. E., *Nature*, 1949, 164, 441.

## ON COEXISTING PYROXENE AND AMPHIBOLE IN ALKALI-GABBRO OF KORAPUT, ORISSA

THE pyroxene and amphibole developing in alkali basaltic magma are expected to show certain common chemical characteristics, as they crystallise in the same chemical environment. The purpose of this note is to demonstrate these chemical characteristics of the two coexisting mafic silicates in alkali-gabbro of Koraput and to discuss the magma chemistry in this view.

The pyroxene in the alkali-gabbro of Koraput is a pink titaniferous salite—a characteristic pyroxene of alkali olivine magma<sup>1,4</sup> (Wilkinson, 1956, Poldervaart, 1962). The coexisting calciferous brown amphibole is to be designated barkevikite though it closely approaches kærutite on the basis of Mg atom in the formula<sup>5</sup> (Wilkinson, 1961).

The chemical compositions of the pyroxene and amphibole along with the atomic ratios for respective oxygen content in the formula are given in Table I. The essential chemical characteristics of the pyroxene are high lime and alumina besides appreciable amount of titania and soda contents. The amphibole is characteristically rich in these constituents. The FeO/MgO ratio (molecular ratio) and the alkali content increase while the lime content falls in the later formed amphibole. This trend in chemical variation is consistent with the accepted reaction principle.

TABLE I

	1	2	3	4	5
SiO <sub>2</sub>	.. 41.52	41.48	Si 162	Si 647	637
TiO <sub>2</sub>	.. 2.83	3.92	Al <sup>4</sup> 38	Al <sup>4</sup> 153	163
Al <sub>2</sub> O <sub>3</sub>	.. 11.96	10.05			
Fe <sub>2</sub> O <sub>3</sub>	.. 5.18	4.06	Al <sup>6</sup> 14	Al <sup>6</sup> 57	18
FeO	.. 9.23	14.93	Ti 8	Ti 33	45
MnO	.. ..	0.16	Fe <sup>3</sup> 151	Fe <sup>3</sup> 60	47
CaO	.. 18.76	10.78	Fe <sup>3</sup> 300	Fe <sup>0</sup> 120	191
MgO	.. 7.39	8.58	Mg 432	Mg 173	198
Na <sub>2</sub> O	.. 1.53	2.89		Mn ..	2
K <sub>2</sub> O	.. 0.34	1.94	Ca 777	Ca 310	177
P <sub>2</sub> O <sub>5</sub>	.. 0.80	..	Na 57	Na 23	86
H <sub>2</sub> O	.. 0.15	1.35	K 8	K 3	38
				H ..	138
	99.70	100.14			

1. Clinopyroxene from alkali-gabbro of Koraput. Analyst: B. P. Gupta.

2. Barkevikite from alkali-gabbro of Koraput. Analyst: W. H. Herdsman.

3. Atomic ratios in 1 for O=600. (CaNaK)<sub>0.84</sub>(FeMgAlTi)<sub>1.11</sub>(SiAl)<sub>2</sub>O<sub>8</sub>.

4. Atomic ratios in 1 for O=2400.

5. Atomic ratios in 2 for (O, OH)=2400. (CaNaK)<sub>3.0</sub>(AlFeMgTi)<sub>5.0</sub>(SiAl)<sub>3.0</sub>=O<sub>22.6</sub>(OH)<sub>1.4</sub>.

The alkali olivine basaltic magma of Koraput, like similar magma in general, was appreciably rich in water as revealed by profuse development of hydrous silicate phases, moderately high  $\text{Fe}_2\text{O}_3/\text{FeO}$  ratio, and frequent modal hematite along with other characters. High water pressure increased the field of crystallisation of pyroxene and favoured accumulation of Al, Ca and Na in the magma by inhibiting crystallisation of plagioclase<sup>2</sup> (Ringwood, 1959). All these elements entered in appreciable amount the structure of the crystallising pyroxene and consequently an aluminous titanosalite resulted. With increasing water and falling temperature the pyroxene became unstable and formation of amphibole was favoured. But the constituents of plagioclase continued to enter the composition of amphibole and promoted crystallisation of calciferous sodic amphibole—barkevikite, in profusion. Low silica activity (as the magma was undersaturated in silica) and concentration of Al in the magma favoured the entry of Ti in the structures of both the mafic silicates<sup>3</sup> (Verhoogen, 1962). Recalculation of the atomic ratios of the pyroxene for  $\text{O}=2400$  (Table I) reveals the closeness in composition of the titanosalite and barkevikite and accounts for their coexistence. In the alkali-gabbro of Koraput, a higher proportion of normative plagioclase than in the mode indicates that the constituents of plagioclase have entered in abundance the compositions of coexisting pyroxene and amphibole. An antipathic relation between modal plagioclase and total of pyroxene *plus* amphibole in the rocks further corroborate this idea. From the above observations it could be conjectured that the trend of crystallisation of both pyroxene and amphibole in alkali basaltic magma would essentially be parallel, as they are expected to persist as calciferous phases though Mg will be replaced at increasing amount by diadochic iron.

The author thanks Prof. S. Ray, Presidency College, Calcutta, and Prof. J. F. G. Wilkinson, University of New England, for their encouragement.

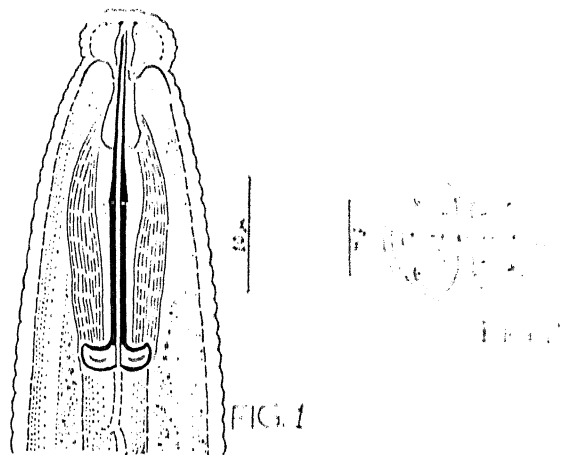
Department of Geology,  
Presidency College,  
Calcutta, *June 24, 1963.*

MIHIR K. BOSE.

ON THE IDENTITY OF *BELONC*  
*LAIMUS HASTULATUS* COLBRAN 1960,  
AND *TYLENCHORHYNCHUS INDICUS*  
SIDDIQI, 1961 (NEMATODA:  
TYLENCHIDA)

COLBRAN (1960) described *Belonolaimus latus* from soil around roots of orange groves in Mundubbera, Queensland, Australia. In the diagnosis, Colbran (loc. cit.) mentioned the presence of four incisures in the lateral field and a short buccal spear. The spear in this species is stout, with well-developed, anteriorly angled basal knobs (Fig. 1D). These characters are of variance with those shown by the type species of the genus *Belonolaimus* Steiner, 1949.

Recently Rau (1963) published the description of three new species of *Belonolamus* and suggested in a footnote that *B. hastulatus* should probably be placed in some other genus. The writer has examined males and females of *B. hastulatus* sent by Dr. Colbran. A comparison of these specimens with those of *Tetolyglenchus indicus* Sadoys, 1960, reveals that the former represents another species in the genus *Tetolyglenchus* Sadoys, 1960. To make sure, the writer studied the color view of *B. hastulatus* and found that, unlike other species of *Belonolamus*, *B. hastulatus* has six well-marked lips and lacks a lateral stripe (Fig. 2). In view of these facts it is considered proper to redesignate *B. hastulatus* as *Tetolyglenchus hastulatus* (Colbran, 1960), n. comb.



FIGS. 1-2. Fig. 1. *Tetolipniscus baicalicus*, anterior end of female. Fig. 2. *Tetolipniscus baicalicus*, dorsal view of female.

In 1961, the writer described seven species of the genus *Tylenchorhynchus* from India. This included the description of *T. indicus*

1. Poldervaart, A., *Jour. Geol. Soc. Indl.*, 1952, **3**, 1.
2. Ringwood, A. E., *Beitrag. Mineralogie und Petrographie*, 1959, **6**, 346.
3. Verhoogen, J. F., *Amer. Jour. Sci.*, 1962, **260**, 211.
4. Wilkinson, J. F. G., *Amer. Mineral.*, 1956, **41**, 121.
5. —, *Ibid.*, 1961, **46**, 340.

Siddiqi, 1961, which was found around roots of sugarcane and some other plants in Uttar Pradesh. At that time no reference was available of Williams' paper (1960) dealing with *Tylenchorhynchus brevilineatus* Williams, 1960. Though the gubernaculum in male of *T. brevilineatus* has been differently shown by Williams, *T. indicus* and *T. brevilineatus* appear to be identical. A study by the writer of the type material of *T. brevilineatus* now deposited at the Rothamsted Experimental Station, Harpenden, England, showed that the gubernaculum in *T. brevilineatus* is almost like the one described by Siddiqi (1961). Therefore, these two species should be regarded as conspecific.

Department of Zoology, M. RAFIQ SIDDIQI.  
Aligarh Muslim University,  
Aligarh (U.P.), India, May 17, 1963.

1. Colbran, R. C., *Qd. J. Agric. Sci.*, 1960, **17** (3), 175.
2. Rau, G. J., *Proc. Helm. Soc. Wash.*, 1963, **30** (1), 119.
3. Siddiqi, M. R., *Nematologica*, 1960, **5**, 73.
4. —, *Z. f. Parasitenk.*, 1961, **21** (1), 46.
5. Williams, J. R., *Res., Inst. Mauritius Sug. Indus.*, Occasional Paper No. 4, 1960, 1.

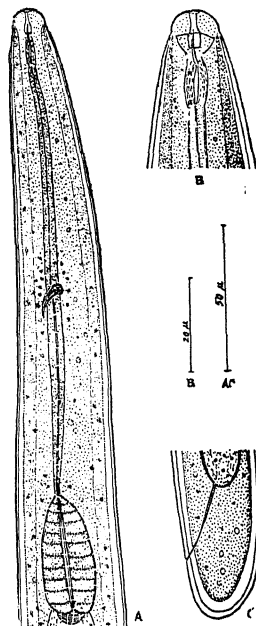
# ON PROLEPTONCHUS AESTIVUS LORDELLO, 1955 (NEMATODA: DORYLAIMOIDEA)

DURING the investigations on plant and soil nematodes of India the authors have collected 15 female specimens of a nematode genus *Proleptonchus* Lordello, 1955 from the soil around the roots of guava, *Psidium guajava* L., from Saharanpur (U.P.). Upon study they were found to represent *Proleptonchus aestivus* reported from Brazil by Lordello (1955). It is for the first time that this genus and species is being reported from India. Measurements and a brief description of the present material is provided.

Measurements: 5 females. L = 1.2–1.5 mm.; a = 32–35; b = 6.0–7.5; c = 70–75; V = 52–53; Spear = 7.0–8.5  $\mu$ ; Spear extension = 10–12  $\mu$ .

Description: Body elongate, cylindrical and slightly arcuate ventrally when relaxed. Head rounded, slightly marked off from the body; lips amalgamated. Amphids large cup-like; amphidial apertures three-fourth as wide as head. Spear short, slender, arcuate, tapering to a fine tip. Spear extension simple without basal flanges. Stomal lining sclerotized, flask-shaped. Esophagus a long slender tube anteriorly and a short basal bulb posteriorly; the latter set

off by a distinct constriction from the former. Cardia well developed. Rectum more than one anal body diameter. Vulva a transverse slit. Vagina about half the corresponding body diameter. Ovary prodelphic and reflexed about



FIGS. A–C. *Proleptonchus aestivus*. Fig. A. Oesophageal region. Fig. B. Anterior end. Fig. C. Posterior end.

halfway back to vulva. Oöcytes arranged in a single row except for a short zone of multiplication. Posterior uterine branch a long pouch measuring 57–70  $\mu$ . Tail rounded, less than one anal body diameter.

Dept. of Zoology, M. SHAMIM JAIRAJPURI.  
Aligarh Muslim Univ., ATHER H. SIDDIQI.  
Aligarh (U.P.), April 16, 1963.

1. Lordello, L. G. E., *Proc. Helm. Soc. Wash.*, 1955, **22** (2), 71.

# A STUDY OF THE MIRACIDIUM OF SINGHIATREMA LONGIFURCA SIMHA, 1958

THE adult *Singhiatrema longifurca* is a parasite in the cloaca and rectum of the common water-snake, *Tropidonotus piscator* in Hyderabad. The eggs in the anterior coils of the uterus contain fully developed miracidia; when these eggs are placed in tap-water, at room temperature, they hatch within four minutes. The miracidium comes out by pushing the operculum.

The miracidium is usually elliptical, but it may assume an oval shape. It is a very fast swimmer, swimming in straight lines, along the bottom of the cavity block. The movements can be arrested by administering methyl green or gelatin to it. It is capable of extension and contraction and a fully extended miracidium measures  $60\mu \times 19\mu$ ; when contracted it assumes an oval shape and measures  $46\mu \times 32\mu$ .

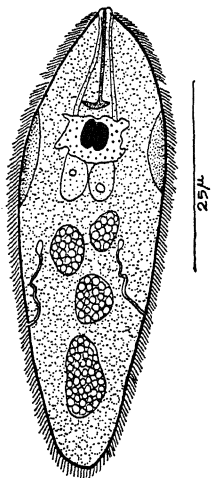


FIG. 1. Diagram of the miracidium of *Singhiatrema longifurca* (Extended specimen).

At the anterior end of the miracidium, it bears a knob-like structure, the terebratorium, which can be protracted or retracted. The posterior end of the body is evenly rounded. The surface of the miracidium appears to be uniformly ciliated. The internal structure of the miracidium consists of an anchor-shaped apical gland, which opens at the terebratorium. Posterior to the base of the apical gland, there is a pair of eyes and the irregular mass of nervous matter, the 'Brain'. Two saccular, contractile glands, the penetration glands, are situated below the brain, and they open with the help of narrow ducts at the base of the terebratorium. Each gland contains a nucleus and is filled with coarsely granulated protoplasm. The apical gland stains light blue with methylene blue and is filled with finely granulated protoplasm. There are two lateral spaces in the anterior region of the body. They appear to be vacuolated spaces.

The excretory system consists of a pair of flame cells with their ducts situated in the 3rd quarter of the body. These ducts open to the outside at the lateral margins of the body. The

posterior part of the miracidial body is filled with the germinal tissue, usually in the shape of balls.

The life of the free-swimming miracidium in the summer months is just two hours, while in the winter it swims for about 8-10 hours.

The miracidia of *Singhiatrema longifurca* closely resembles the miracidia of *Parorchis acanthus* described by Rees, 1940. It can, however, be differentiated from the latter by the absence of the 'single mother redia'.

Dept. of Zoology, SHYAM SUNDER SIMHA.  
Univ. College of Sci., PRABHAKAR DESHPANDE.  
Osmania University,  
Hyderabad-7, May 17, 1963.

1. Rees, G., *Parasitology*, 1940, **32**, 372.
2. Simha, S. S., *Z. parasitenkunde*, 1958, **18**, 161.

#### FREE AMINO-ACIDS IN A DIGENETIC TREMATODE, *PARAMPHISTOMUM* *CERVI*

YOSHIMA (1930)<sup>1</sup> recovered fourteen amino-acids in *Ascaris lumbricoides* and Kent (1947)<sup>2</sup> reported eight amino-acids in *Moniezia expansa*. von Brand (1952)<sup>3</sup> reviewed the previous work and reported a total of fourteen amino-acids from tapeworms and nematodes. Aldrich, Chandler and Daughtery (1954)<sup>4</sup> identified fourteen  $\alpha$ -amino-acids in protein hydrolysates of *Hymenolepis diminuta*, while Goodchild and Wells (1957)<sup>5</sup> reported twenty amino-acids from *Hymenolepis diminuta*.

In the course of present investigation the author has studied free amino-acids in a digenetic trematode, *Paramphistomum cervi*, commonly infesting the cattle in India. The parasites were recovered from the rumen of buffaloes, slaughtered in the local municipal slaughter house. The parasites were then washed with glass-distilled water and deproteinised with 80% ethyl alcohol, centrifuged at 300 r.p.m. and the clear liquid separated from the precipitated proteins. The precipitate was washed three times with a few microlitres of 80% alcohol to ensure complete extraction of free amino-acids. The alcoholic extract was evaporated under vacuum to a volume of 10 microlitres and then subjected to two-dimensional paper partition chromatography, using a different solvent system for each dimension. The solvent employed for the first dimension was butanol phase of a mixture of *n*-butanol, acetic acid and water (4:1:5 v/v). For the second dimension *n*-propanol diethyl-



amine water (85:4:15 v/v) was used as the solvent. The amino-acids were spotted on Whatman No. 1 (18.25" × 22.5") filter-paper. The chromatograms were developed by spraying with 0.25% solution of ninhydrin in acetone and heating at 60° C. for ten minutes. The amino-acids were identified by comparing the position of the spots from the sample with those of the references developed simultaneously on the same paper.

Thirteen  $\alpha$ -amino-acids have been identified chromatographically from the alcoholic extracts of *Paramphistomum cervi*.  $\alpha$ -Amino recovered include Cystine, cysteine, lysine, arginine, aspartic acid, serine, glycine, alanine, tyrosine, valine, norvaline, leucine, isoleucine and proline.

Department of Biology, D. P. SINGAL.  
Delhi College,  
(University of Delhi),  
Ajmeri Gate, Delhi-6, April 9, 1963.

1. Yoshima, S., *J. Biochem. Tokyo*, 1930, 12, 27.
2. Kent, F. N., *Bull. soc. Neuchatel Sci. Nat.*, 1947, 70, 85.
3. von Brand, T., *Chemical Physiology of Endoparasitic Animals*, Academic Press, New York, 1952.
4. Aldrich, D. V., Chandler, A. C. and Daughtery, J. W., *Exptl. Parasit.*, 1954, 3, 173.
5. Goodchild, C. G. and Wells, O. C., *Ibid.*, 1957, 6, 575.

#### A NOTE ON A NEW ENTOMOGENOUS BACTERIA

THE entomogenous spore-forming bacteria are of increasing interest because of great potentiality for insect control. The best known examples of use of bacteria in the control of destructive pests are with *Bacillus popillae* Dutky and *B. thuringiensis* Berliner. The former is, however, not very rapid and effective in action on account of the longer incubation period of 2-4 weeks and it also cannot be readily grown in laboratory media. The latter can be easily grown in laboratory and has been found pathogenic for a large number of economically important pests. Its use in the form of microbial insecticide 'thuricide' is well known.

The authors, during the course of investigations on *Utetheisa pulchella* Linn. came across heavy mortality in the larval stages both in the laboratory and in the field. These larvæ were found moving sluggishly and died after a few hours. The death was believed due to certain micro-organism. In microscopic examination, the bacterium was detected. The isolated and purified culture of bacterium was sent to

Dr. Hayward of Commonwealth Mycological Institute, Engand, for examination and identification of the organism. He has reported it to be *Bacillus sphaericus* Neide. The strain is gram-negative on various agar media with occasional gram-positive granules. Casein agar is the best medium for induction of sporulation. The mature spores are spherical, when attached to the vegetative cell.

The bacterium after isolation from the body of the thoroughly sterilized larva of *U. pulchella* L. was inoculated in the nutrient slants for culture. Purification was done by single colony isolation method. The cultures were compared in different slants and utilized for proving the pathogenicity by following Koch's postulate.

The pathogenicity of the bacterium was tested against the larvæ of *Utetheisa pulchella* Linn., *Chilo zonellus* Swinh. and *Athalia proxima* Klug. The fresh and healthy leaves of the food plants, after being thoroughly washed with tap and distilled water, were sprinkled with bacterium dilution with the help of an atomizer. Only healthy larvæ were allowed to feed on these artificially infected leaves. The different concentrations of bacterial suspensions used were 1:10, 1:100, 1:1000, 1:10000, prepared by dilution method in sterilized distilled water and quantitative examination of bacterium was done by "Direct microscope method" for determining the number of bacteria per millilitre.

During the course of experiments, the bacterium caused mortality in all the cases. The death occurs due to lethal septicemia and the larvæ die very rapidly after showing sluggish movements for some period after infection. It is thus a promising micro-organism causing mortality in insects larvæ and can be effectively used in the control of insects specially surface feeders of Lepidoptera and other groups. Its pathogenicity seems to be a persistent characteristic and can be compared with *B. thuringiensis* with which it has proved equally pathogenic.

This is the first record of the pathogenicity of this bacterium on this host as well as on any other insect, as the authors could not come across any reference of its infection in insects.

The authors are of opinion that a suitable microbial insecticide in the form of a wettable powder can be manufactured with this bacterium as a pathogen.

Entomology Department, V. N. UPADHYAYA.  
College of Agriculture, M. L. NAYAK.  
Gwalior, May 31, 1963. Y. S. RATHORE.

### A STUDY ON THE FLORAL MORPHOGENESIS IN RICE PLANT

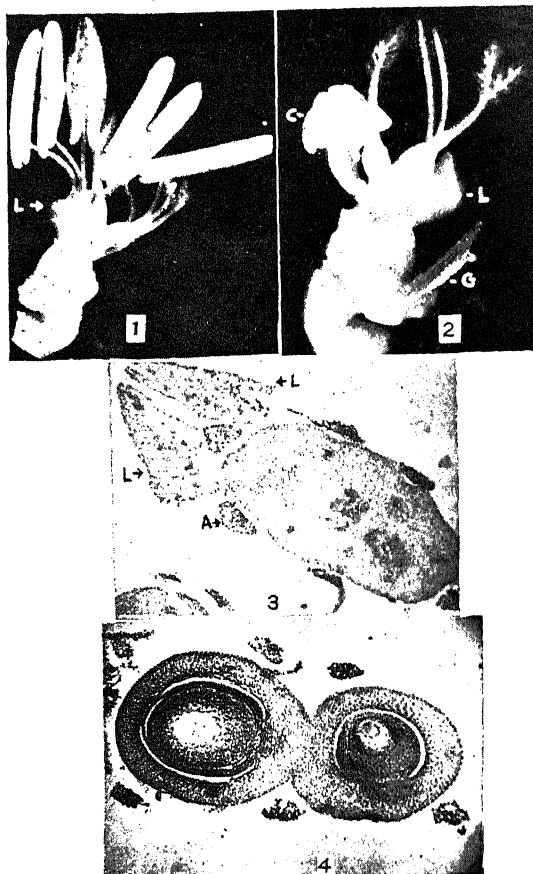
AN interesting cultivated variety of rice plant, *Oryza sativa* L. var. *Plena*,<sup>1</sup> bears in addition to the usual floral parts, a number of pistils in a spikelet and frequently two of them develop to form "Double Rice",<sup>2,3</sup> also termed as 'Polygynous', 'Multiple pistilled', 'Plural ovaried' or 'Multiple. seeded' paddy. The occasional development of twin plants may owe its origin to either two ovules of a single ovary, as found in the polyembryonic rice,<sup>4</sup> or two separate ovaries being evident in the double riced paddies.<sup>2</sup>

Although a large number of ovaries were noted to develop in many spikelets of the *Plena* variety during the early stages of growth, mostly one to two only form mature grains, varying in size and completeness of development. The two members of the biovarial spikelets are joined together at the base, placed in the plane of and borne on the two inner sides of the pair of flowering glumes, the ovary on the lemma-side is larger and healthier than the second one (Fig. 1). Along with the multi-ovarial condition, a number of interesting morphological puzzles or rare floral abnormalities in pistil including development of single stigma, deformation of the stigma into aberrant callus-like growth, etc., were often observed (Fig. 2). A few references may be indicated of supernumerary pistils and deformed stamens,<sup>5</sup> and also of double kernels<sup>6</sup> within a single spikelet of Japonica mutants.

The morphogenetic investigation on the vascular supply to the ovaries, the histological disposition of the tissues in the covering glumes and the orientation of the ovules in the pair of ovaries forming the double rice was made. The vascular component of the rachilla or spikelet axis divides or branches unequally at the base of the ovaries resulting in the stronger trace supplying the median larger ovary and a smaller one to the palea-side member (Fig. 3). Interestingly, the ovule in the terminal lemma- or lodicule-side ovary was observed to face the basal midrib part of the lemma, whereas the ovule belonging to the palea-side one was laterally away from the median axis and placed transversely in a plane perpendicular to that of the lemma-side (Fig. 4).

On putting for germination, the unhusked 2-riced mature paddies either failed to grow or formed always only one seedling. After careful examination, it was revealed that the growing embryo of the 2-seeded caryopsis

belonged to the median lemma-side rice and that of the palea-side one failed to do so; but



FIGS. 1-4. Fig. 1. Spikelet of a double-riced *Plena* variety after removing off the glumes showing lodicules (L), six anthers and two ovaries with two stigmas each, the ovary on the lodicular side being larger,  $\times 14$ . Fig. 2. Flower of the double-riced paddy showing empty glume (G) below and three ovaries. The bigger ovary on the lodicular side (L) bears two stigmas, the middle one single stigma and the third a callus-like growth (C) at the top,  $\times 21$ . Fig. 3. The joint basal region of the double ovaries (transverse section) showing vascularization to the two pistils, encircled by six anther filaments (A). L, lodicules,  $\times 48$ . Fig. 4. The double ovaries (transverse section) showing the normal ovular placement in the bigger ovary and the transversely-oriented ovules in the lateral smaller one,  $\times 56$ .

when the two groups were allowed to germinate separately after removing off the husks, both grew freely under the same cultural conditions. When the unhusked mature grains get soaked, the primary lemma-side embryo like that of the normal 1-riced paddies swells up in the basal space inside lemma, splits open at its particular softer middle region in front and thus enables the radicle and plumule to emerge out

without difficulty.<sup>2</sup> On the contrary, the transversely-placed palea-side embryo faces the stiffer lateral part of the husk and is not in addition provided with any empty interspace, specially when the endosperm moistens and swells, as a result some mechanical hindrance is imposed over the swelling and growing up of the embryo while cultured unhusked.

The author thanks the Indian Central Jute Committee for providing facilities to carry out the work in the Jute Agricultural Research Institute, Barrackpore, Dr. S. Sen for the photographic illustrations and the National Institute of Sciences of India for the award of a Senior Research Fellowship.

State Agricultural BISWAMBHAR SAHA.

Research Institute,  
238, Netaji Subhash  
Chandra Bose Road,  
Tollygunge, Calcutta-40, May 14, 1963.

1. Prain, D., *Bengal Plants*, West Newman & Co., London, 2, 1184.
2. Parthasarathy, N., *Madras Agr. J.*, 1931, 19, 290.
3. Datta, R. M. and Paul, A. K., *Science*, 1951, 113, (No. 2936), 491.
4. Ramiah, K., Parthasarathy, N. and Ramanujam, S., *Ind. J. Agr. Sci.*, 1935, 5, 119.
5. Nagai, I., *Japanica Rice: Its Breeding and Culture*, Yokendo Ltd., Tokyo, 1959, p. 299.
6. Morinaga, T. and Tajiri, T., *J. Genet. Japan*, 1941, 17, 37.

# STUDY OF THE VARIOUS ASPECTS OF PLASMODIAL GROWTH OF *PHYSARUM WINGATENSE* MACBR.

Watery white-coloured plasmodium of *Physarum wingatense* Macbr. was isolated from old bark on 2% Difco Bacto agar medium (Alexopoulos, 1959). A clean plasmodium was obtained after giving frequent changes in fresh media. The plasmodium appeared like a branched tube having one end flattened into a fan-like structure with a flowing mass of protoplasm. It exhibited vigorous growth and could be differentiated into three regions—the fan-like zone formation, the zone of reticulum, and the tube-like zone of maturation (Fig. 1). Except the advancing zone of formation the plasmodium could be differentiated into two layers: a peripheral layer with no protoplasmic flow and a central layer having unidirectional protoplasmic flow. The protoplasmic flow was maximum in the fan-like region with a gradual retarding tendency in the reticulum and ultimately in the zone of maturation there was no protoplasmic flow at all. This was

recorded by feeding the plasmodium at different regions with carmine dye particles which flowed along with the flow of the plasmodial protoplasm. The plasmodium crawled on the medium by frequently changing position and left behind a trail containing larger carmine particles (Fig. 2). The freshly formed trail, which appeared to be composed of a mass of loose particles, could be lifted up from the medium with a fine needle. On treating the trail with phloxin stain (Martin, 1952) the outer loose particles were dispersed, and slowly there appeared a compact structure which responded to the stain (Fig. 3). The trail lost its compactness and stainability with time.

The plasmodium was separated into several portions which were transferred in the following three kinds of media and were incubated at a temperature of 27° C. :—

(i) Liquid medium (Allen and Winston, 1950). The plasmodium was first placed on a piece of paper towel and then both were put in the liquid medium. The piece of paper towel was used to give support to the plasmodium and to prevent it from being completely submerged in the medium.

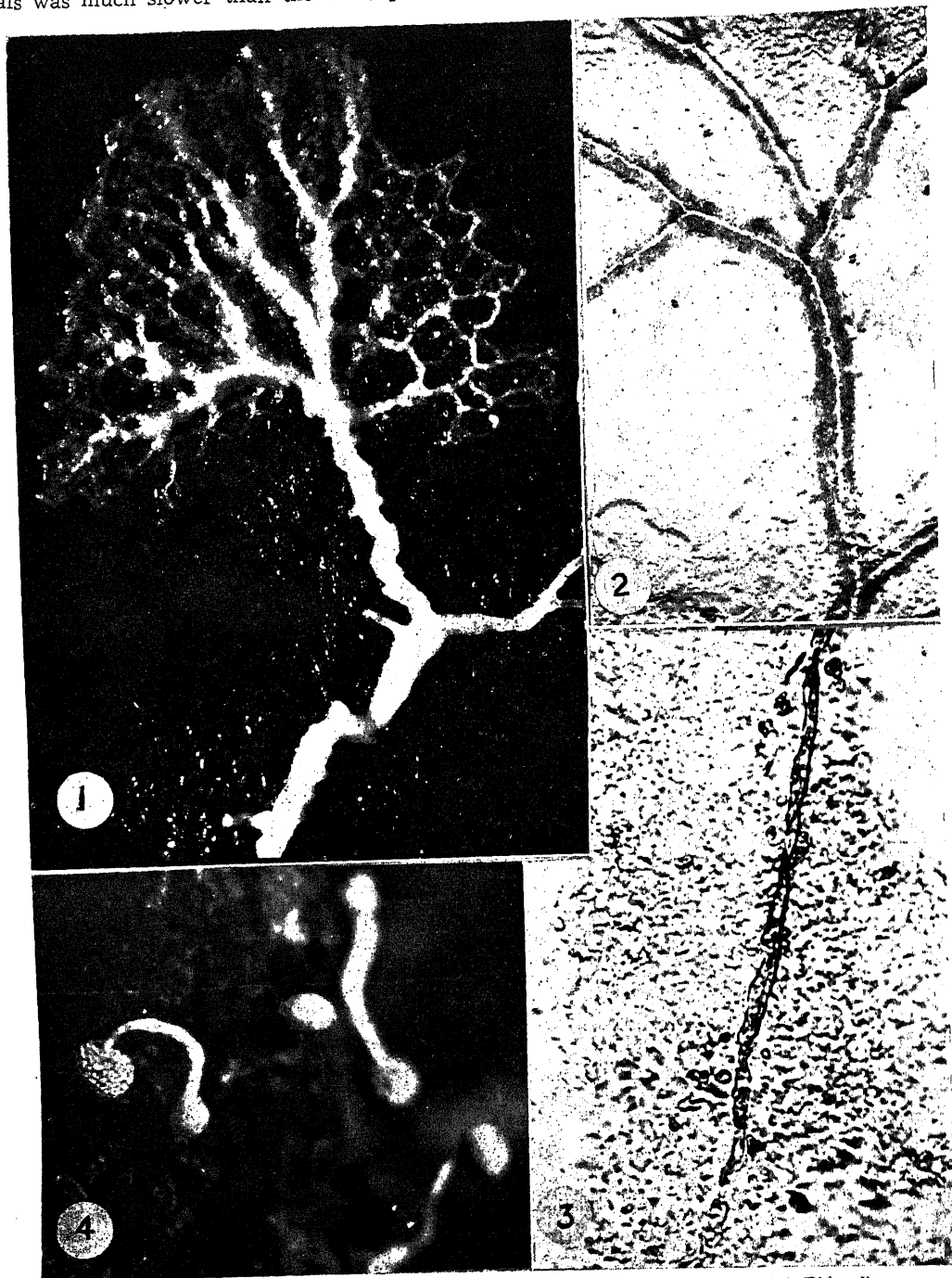
(ii) 2% Knop's agar medium (Alexopoulos, 1960).

(iii) 2% Oat meal agar medium.

Of the two kinds of solid media used, faster growth of the plasmodium was noticed on 2% Oat-meal agar than on the 2% Knop's agar. On 2% Knop's agar medium the plasmodium appeared healthier though the rate of growth was very slow. The liquid medium was suitable only to keep the plasmodium growing.

The development of fruit bodies did not occur until the plasmodium had attained certain maturity. Temperature of 27° C. was found quite suitable for fruiting, but the factors are unknown that induce fruiting. The formation of fruit bodies was initiated by the development of protoplasmic blobs, formed by receding of the plasmodial protoplasm, on the surface of the medium at the junction points of the plasmodial reticulum forming sporangial initials (Fig. 4). The protoplasm of the sporangial initials presented no essentially different appearance from that of the plasmodial stage except that the protoplasm appeared much denser. Immediately after the formation of sporangial initials fruit bodies started developing by the vertical elongation and gradual differentiation of the sporangial initials into head and stalk of the fruit body (Fig. 4). The entire protoplasmic mass of each

sporangial initial was transformed into a single sporangium. The formation of sporangial initials was much slower than the development of sporangia from the sporangial initials. The sporangial development started in the late afternoon and the whole process was completed



FIGS. 1-4. *Physarum wingatense*. Fig. 1. Well-developed plasmodium on 2% Difco Bacto agar medium,  $\times 16$ . Fig. 2. Formation of trail by the plasmodium,  $\times 16$ . Fig. 3. Phloxin stained trail,  $\times 260$ . Fig. 4. Sporangial initial and development of sporangia from the sporangial initials,  $\times 23$ .

by early next morning. It is interesting to note that all the sporangia developed almost simultaneously in spite of the fact that the protoplasmic connections between the sporangial initials were lost early. The plasmodium in the liquid medium failed to produce any fruit body.

Thanks are due to Dr. D. P. Rogers, Professor of Botany, University of Illinois, Urbana, Illinois, under whose supervision the present investigation was carried out.

Mycology and Plant

ASOK KR. KAR.

Pathology Laboratory,

Department of Botany,

Presidency College, Calcutta, May 27, 1963.

1. Alexopoulos, C. J., *Amer. Jour. Bot.*, 1959, **46**, 140.
2. *Ibid.*, 1960, **47**, 37.
3. Allen, P. J. and Winston, H. Price, *Ibid.*, 1950, **37**, 393.
4. Lister, G., *A Monograph of the Mycetozoa*, Oliver and Boyd, Edinburgh, 1925.
5. Martin, G. W., "Revision of the North Central Tremellales," *Univ. Iowa Studies Nat. Hist.*, 1952, **19** (3).

## POLLEN MORPHOLOGY OF TWO SPECIES OF OROBANCHACEAE

The present note refers to the pollen of two commonly occurring species of South India—viz., *Orobanche nicotianae* Wight and *Aeginetia indica* L. According to Gamble (1957), the former is widely distributed in the Northern Circars and the Deccan of South India, being a destructive parasite on the cultivated tobacco crops, while the latter is parasitic on the roots of many plants and occurs on the humus soils of the Northern Circars and the Western Ghats at an altitude of 1,000-1,300 metres.

The only available account for the pollen of the species of *Orobanche* and *Aeginetia* is from

the work of Masa Ikuse (1956). She mentions the occurrence of non-aperturate and tricolpoidate grains in *Orobanche minor* and *O. coerulea*, while *Aeginetia indica* and *A. sinensis* have tricolpoidate grains. No mention of the presence of non-aperturate grains in the family was made by Erdtman (1952).

The anthers are collected from mature flower-buds in the field and the pollen has been prepared by acetolysis and is chlorinated. The measurements given below are for acetolysed chlorinated grains.

*Orobanche nicotianae* WIGHT (FIG. 1).

Pollen grains irregular, usually sub-spheroidal and are of two types: (a) tricolpoidate grains with irregular furrow margin; (b) non-aperturate grains which measure  $24\mu$ . The tricolpoidate grains measure  $24\mu$  both in polar and equatorial views. Polar area  $12.8\mu$ . Thickness of exine  $1.6\mu$ . Sexine thicker than nexine, faintly tegillate, surface faintly reticulate.

The author could not observe in the species under study, the echinulate condition (presence of spines less than  $1\mu$ ) as mentioned by Ikuse (1956) in the species described from Japan.

*Aeginetia indica* L. (FIG. 2)

Pollen grains irregular, sub-prolate, tricolpate, furrow margin slightly irregular. Polar view:  $28.8\mu$ ; Equatorial view:  $27.2\mu$ ; Polar area:  $3.2\mu$ ; Thickness of exine:  $1.6\mu$ . Sexine thicker than nexine, grains very faintly tegillate. Surface pattern is faint.

In the species of *Aeginetia indica* var. *gracilis* described by Ikuse (1956), mention is made of the presence of tricolpoidate grains, echinulate condition of the exine which is finely reticulate, but none of the characters could be observed in the material described.

The two species under description differ in certain respects already mentioned from those

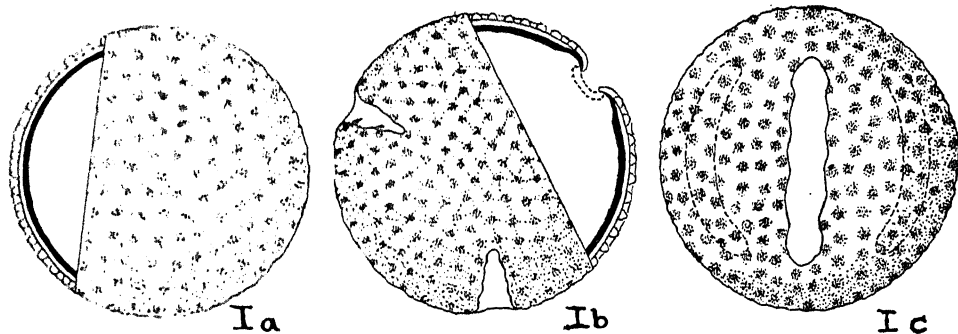


FIG. 1. *Orobanche nicotianae*. (a) Non-aperturate grain,  $\times 1,500$ . (b) Tricolpoidate grain—Polar view,  $\times 1,500$ . (c) Equatorial view,  $\times 1,500$ .

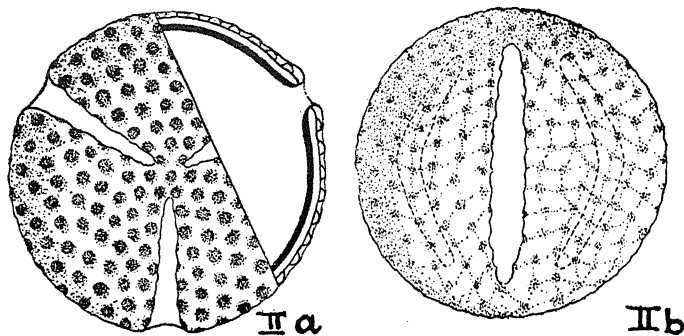


FIG. 2. *Aeginetia indica*. (a) Tricolpate pollen grain—Polar view,  $\times 1,500$ .  
(b) Equatorial view,  $\times 1,500$ .

described by Ikuse (1956) from Japan. In the species described above, it is interesting to note the occurrence of two types of grains (tricolpate and non-speraturate) in *Orobancha nicotianæ* which seems to occupy an intermediate position between the non-aperturate grains of other species of *Orobancha* and the tricolpate grains of *Aeginetia*.

The author wishes to express his sincere thanks to Prof. F. H. Guinet of the French Institute at Pondicherry for the critical perusal of the manuscript and material and for valuable suggestions in the preparation of this paper.

Botany Department, T. SESHAGIRI RAO.  
S.K.B.R. College, Amalapuram,  
East Godavari District, February 15, 1963.

1. Erdtman, G., *Pollen Morphology and Plant Taxonomy (Angiosperms)*, Stockholm, 1952.
2. Gamble, J. S., *Flora of Presidency of Madras*, Vol. II, Botanical Survey of India, Calcutta, 1957.
3. Ikuse, M., *Pollen Grains of Japan*, Tokyo, 1956.

#### A NEW SPECIES OF *CURVULARIA* ON THE LEAVES OF *CARICA PAPAYA* L.

THE leaves of *Carica papaya* at Allahabad Agricultural Institute, Naini, exhibited severe dark gray scattered and marginal spots in October, 1962. Isolations from the diseased fragments consistently resulted in highly sporulating cultures of *Curvularia*. The size of conidia and conidiophores showed some similarity with those reported for *Malustela acria*. The genus *Malustela* was created by Batista *et al.* in 1960 to accommodate a typical *Curvularia*-like fungus which was characterized by formation of very elongated and branched synnemata bearing the conidiophores. The present species, however, differed from *M. acria* in having much smaller and highly lobed synnemata (*vide* Fig. 1) which never bore the conidiophores. The fungus was cultured on a number of nutrient media and it was found that synnemata formation was not a consistent feature. These bodies were produced only on P.D.A. and



FIGS. 1-2. Fig. 1. Photomicrograph showing synnemata,  $\times 250$ . Fig. 2. Photomicrograph showing conidia and conidiophore,  $\times 650$ .

solidified Asthana and Hawker's medium A. The culture was sent to Dr. Ellis of C.M.I., Kew, who has expressed the following opinion. "This may be a distinct species of *Curvularia*. The conidia and conidiophores bear a close resemblance to those of *Malustela aëria* but the stroma are very short on the plates of P.D.A."

The present isolate is being placed in the genus *Curvularia* and not *Malustela* because synnemata formation which is a distinct character of the latter genus is a variable feature of this form which can be modified or prevented by changing the nutritional environment. The dimensions of various vegetative structures do not agree with any of the existing species of *Curvularia* and it is, therefore, being described as a new species, viz., *Curvularia carica-papayæ* sp. nov. having the following morphological characters:—

Hyphæ hyaline, branched, septate, 1.5–2.8  $\mu$  wide; conidiophores hyaline or lightly coloured, long, unbranched, septate, measuring 60–100  $\times$  6.0–8.0  $\mu$  (average 82.5  $\times$  7.2  $\mu$ ); conidia one- to two-septate, hyaline when young, measuring 12.8–18.0  $\times$  6–8  $\mu$  (average 15.5  $\times$  6.8  $\mu$ ); four-celled at maturity, with the 2 middle cells bigger than the apical and the basal cells, light brown, with the distal cells olive green in colour 16–28  $\times$  8–12  $\mu$  (average 22  $\times$  10  $\mu$ ); synnemata short, unbranched, dark gray, 223–408  $\times$  172–220  $\mu$  (average 362–182  $\mu$ ) with several mycelioid appendages.

Note.—Distinct dark gray and yellow zonation seen on reverse side of the colony when cultured on potato dextrose agar medium.

Isolated from the leaves of *Carica papaya*, culture deposited in C.M.I., Kew (No. 96846).

#### LATIN TRANSLATION

Hyphæ hyalinæ, furcatæ, septatæ, 1.5–2.8  $\mu$  latæ; conidiophori hyalini vel pallide colorati; longi, haud ramosi, septati, 60–100  $\times$  6.0–8.0  $\mu$  (mediet. 82.5  $\times$  7.2  $\mu$ ); conidia semel vel bis septata, juvenilia quidem hyalina, 12.8–18.0  $\times$  6–8  $\mu$  (mediet. 15.5  $\times$  6.8  $\mu$ ), matura vero quatter-cellularia, cellulis mediis largioribus cellula apicali vel basali, pallide brunneis; cellulæ distantes olivaceo-virides, 16–28  $\times$  8–12  $\mu$  (mediet. 22  $\times$  10  $\mu$ ); synnemata brevina, haud furcata, fusce, grisea, 228–408  $\times$  172–220  $\mu$  (mediet. 362  $\times$  182  $\mu$ ) appendicibus nonnullis mycelioidis, conidiophoris raris. Nota bene: Zonatio distincta fusce grisea et lutea clara apparet in facie versa coloniae, quæ colitur in agarò solanaceo dextroso.

Lectus in foliis *Caricæ papayæ*; cultura posita in C.M.I., Kew (No. 96846).

The authors are grateful to Professor R. N. Tandon for providing laboratory facilities, to Dr. J. C. F. Hopkins and Dr. Ellis of C.M.I., Kew, for their opinion and to Prof. H. Santapau for the Latin diagnosis.

H. P. SRIVASTAVA.

K. S. BILGRAMI.

Department of Botany,  
University of Allahabad (India),  
May 16, 1963.

1. Batista, A., Chaves, Lima, *J. Americo de and Vasconcelos, C.T. de, Universidade do Recife Instituto de Micologia Publication No. 263, 1960.*
2. Boedijn, K. B., *Bull. Jard. Bot. Buitenz., 1933, 13, 120.*
3. Groves, J. W. and Skolko, A. J., *Canad. J. Res., 1945, 23 A, 94.*
4. Subramanian, C. V., *Proc. Ind. Acad. Sci., 1953, 38 B, 27.*
5. Tandon, R. N. and Bilgrami, K. S., *Curr. Sci., 1962, 31, 254.*

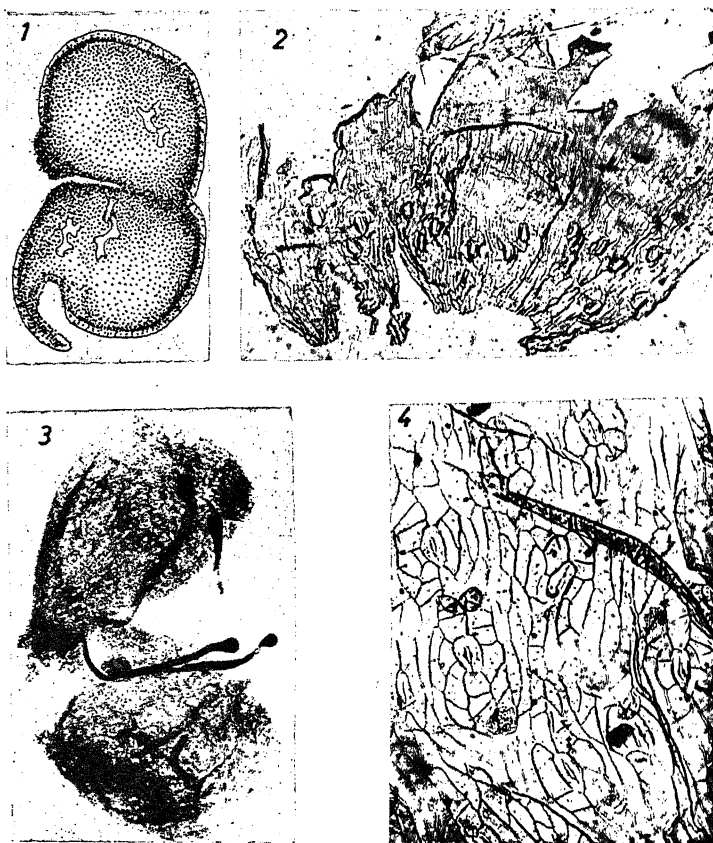
#### THE EPIDERMAL STRUCTURE OF THE SPORANGIA OF SOME MODERN CYCADS

CUTICULAR AND EPIDERMAL study of the sporangia of *Bowenia serrulata* Chamberlain, *Ceratozamia mexicana* Brong., *Cycas beddomei* Dyer, *C. circinnalis* Linn., *C. media* R. Brown, *C. pectinata* Griff., *C. revoluta* Thunb., *C. rumphii* Miq., *Dioon edule* Lindl., *Encephalartos* sp., *Microcycas calocoma* Miq., *Stangeria paradoxa* Th. Moore and *Zamia floridana* A. DC. has been made. In a surface view their epidermis or exothecium shows thick-walled cells which are short or polygonal in the apical region, longitudinally elongated in the middle portion and usually again somewhat shorter towards the basal end. Shorter cells are also seen along the line of dehiscence, e.g., in *Stangeria*. In *Bowenia* relatively short cells occur in the stomatiferous bands.

The surface walls of epidermal cells in *Macrozamia* show simple, oval or rounded pits. The anticlinal walls which are usually straight or arched are sometimes stratified and so excessively thick that their lumen becomes almost completely obliterated and the numerous pits occurring in the walls of such cells also appear like narrow canals radiating from the central lumen. In *Bowenia*, *Dioon* and *Zamia* the sporangial epidermis consists of two types of cells: some of them have a clear lumen while others are filled with dark contents.

The sporangia of *Ceratozamia*, *Dioon*, *Encephalartos* and *Zamia* often show simple bicelled hairs but they are absent in the other forms studied by us. Hairs are usually distributed in the basal region (see Fig. 3) but in

usually confined to the basal extremity of the sporangia (see Fig. 2) but in *Ceratozamia*, *Encephalartos* and *Zamia* they extend up to the middle region. In *Bowenia* two narrow stomatiferous bands run on either side



FIGS. 1-4. Fig. 1. *Microcycas calocoma*, phototracing of split sporangial sac showing idioblasts,  $\times 25$ . Fig. 2. *Stangeria paradoxa*, outer cuticle of sporangium showing numerous stomata towards the base,  $\times 36$ . Fig. 3. *Ceratozamia mexicana*, sporangial wall showing dark coloured epidermal hairs,  $\times 27$ . Fig. 4. *Bowenia serrulata*, outer cuticle of sporangium showing a number of typical stomata,  $\times 148$ .

*Dioon* they occur plentifully all over the sporangial surface from its very base right up to its apex. The sporangial hairs of *Encephalartos* and *Zamia* are all of one type but those of *Ceratozamia* and *Dioon* are often of two types: some are made up of thick-walled cells and others have thin-walled cells.

Stomata are present in the sporangial epidermis of all genera of Cycadales except *Cycas* and *Dioon*. According to McLean and Cook<sup>1</sup> the sporangia of *Cycas* too are stomatiferous but we could find no stomata whatsoever in the sporangia of all the six species which we investigated. When present stomata are

of the dehiscence line from the basal stomatiferous region up to the lower limit of the apical cap of exothecial cells. Wherever they are found sporangial stomata are just like the foliar stomata of a species.

Maceration of mature sporangial wall yields an outer smooth and an inner granular membrane. The cells of the outer cuticle are just like those of the epidermis but the anticlinal walls of the former generally appear thinner and the lignin lamellæ of the guard cell walls are also lost. Macerated guard cells, however, show thickened cutin bands on their dorsal walls.



Sporangia of *Macrozamia*, *Microcycas* and *Zamia* are unique in showing lobed sclereids inside the spore sacs (see Fig. 1).

Stomatiferous sporangia are relatively rare among plants. The only notable exceptions are the sporangia (sporogonia) of *Anthoceros*, *Sphagnum* and a number of mosses<sup>2</sup> among the Bryophyta; the sporangia of some Ophioglossaceae<sup>3</sup> among the Pteridophyta; the microsporangia of *Antevsia*<sup>4</sup> and the above-mentioned Cycadales among the gymnosperms. If, in addition, the homology of the nucellus and the megasporangium wall is taken into consideration, the nucellar stomata occurring in *Cycas*<sup>5</sup> and *Zamia*<sup>6</sup> may also be mentioned here. Nevertheless, the stomata found in the seed coats and stamens of some other seed plants<sup>7</sup> could be excluded because they are not truly situated on the surface of the spore-sac wall.

Like the occurrence of vessels in unrelated groups, the odd occurrence of stomata in the sporangia of these plants may be due to homoplasy and one need not, therefore, attach any phylogenetic significance to this character although wherever they are found, the restricted occurrence of sporangial stomata could be a useful systematic distinction.

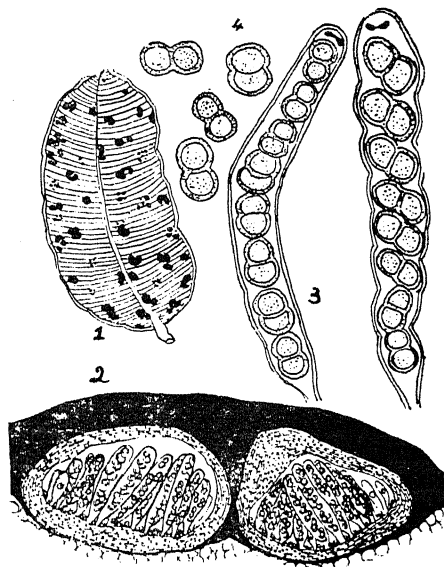
Botany Department, DIVYA DARSHAN PANT.  
The University, DEVENDRA DATT NAUTIYAL.  
Allahabad (India), May 17, 1963.

1. McLean, R. C. and Cook-Imvey, W. R., *The Textbook of Theoretical Botany*, 1951.
2. Paton, J. A., *Trans. Brit. Bry. Soc.*, 1957, 3, part 2, 288; Paton, J. A., and Pearce, J. U., *Trans. Brit. Bry. Soc.*, 1957, 3, part 2, 242.
3. Eames, A. J., *Morphology of Vascular Plants Lower Groups (Psilophytales to Ficales)*, 1936.
4. Townrow, J. A., *Palaeontology*, 1960, 3, Part 3, 333.
5. Pant, D. D. and Nautiyal, D. D., *Curr. Sci.*, 1962, 31, 75.
6. Shapiro, S., *Amer. J. Bot.*, 1951, 38, 47.
7. Lang, W. H., *Ann. Bot.*, 1897, 11, 421; Eames, A. J. and MacDaniels, L. H., *An Introduction to Plant Anatomy*, 1947; Esau, Katherine, *Plant Anatomy*, 1953.

### PLAGIOSTIGME DEODIKARII SP. NOV. FROM INDIA

In the course of his survey of the Maharashtra State for ascomycetes fungi, the writer collected a tar-spot like fungus infecting leaves of *Syzygium jambolana* DC. at Mahabaleshwar at an elevation of about 4,500 ft. during the cold months of 1962. The fungus was typically folliculose and manifested itself in the form of dark black raised waxy lesions. It was entirely absent from the plants growing at the lower altitudes.

Sections through the infection spots revealed the presence of 1-3 ovoid perithecia deeply embedded in a stroma covered over by a thick and dark shield-like layer above, non-ostiolate with paraphysate 8-spored asci and 2-celled ascospores. The fungus was identified through the courtesy of Dr. E. Muller of the Institute of Special Botany, Zurich, as a species of *Plagiostigme*.



FIGS. 1-4. Fig. 1. Habit,  $\times \frac{1}{2}$  Nat. Fig. 2. Perithecia,  $\times 57$ . Fig. 3. Asci,  $\times 246$ . Fig. 4. Ascospores,  $\times 246$ .

The genus *Plagiostigme* Syd. is represented by only 2 species, one each collected from Ecuador (Petrak, 1949) and Costa Rica (Sydow, 1925) with *P. couraliae* Syd. as type. The genus is absent from the Indian Flora and has not been reported from *Syzygium* spp. so far. These considerations aroused special interest and a critical study was made of the Indian Collection. The results of the comparative study are presented in Table I.

It is, therefore, proposed to present this fungus as a new species on the basis of morphological characters, dimensions and host relationship with Latin diagnosis:

*Plagiostigme deodikarii* sp. nov.

S. ANANTHANARAYANAN

Infectionis maculae epiphyllae, piceae, dispersae, saepe aggregatae, elevatae, lenticulares, cereae, 0.5-1.5 cm. Perithecia ovoidea, 1-3 in singulis

TABLE I

Species	Host	Perithecia	Asci	Ascospore	Authority
1. <i>P. ocellata</i>	<i>Couratia rosea</i> , Donn.	160-240 $\mu$ diam., Ostiole oblique	75-100 $\times$ 10-18 $\mu$ oblongocylavate	17-19 $\mu$ , 1-septate, upper cell 7.5-9.5 $\mu$ & ellip- soid and lower cell 5.5- 6 $\mu$ and obtuse. Spores distichous or mono- stichous	P. Sydow, 1925
2. <i>P. clypeata</i>	<i>Disterigma</i> <i>acuminatum</i> Niedenzu	300-450 $\mu$ diam., Ostiole if pre- sent oblique	65-80 $\times$ 12-15 $\mu$ clavate or sub- fusoid	13-22 $\times$ 5-7.5 $\mu$ Disti- chous, oblongocylavate or elongatipyiform, 1- septate slightly or non constricted at septa	F. Petrak, 1949
3. <i>P. species</i> (India)	<i>Syzygium jambo- lanum</i> DC.	301-430 $\mu$ diam., with a thick black stromatic layer above	155-185 $\times$ 17-2- 19.4 $\mu$ bitunicate, always cylindrical with a prominent apical apparatus	21.5-28 $\times$ 13-15.5 $\mu$ , 1-septate deeply con- stricted at septum, both cells rounded and monostichous	S. Ananthanarayanan, 1963

maculis, non-ostiolata, alte infixa in mesophyl-  
lum, crassostrato stromatico nigro supra, 301-  
430  $\mu$  diam. Asci aparaphysati, bitunicati,  
cylindrici, subsessiles, octospori, ornati apparatu  
apicali discoideo, oblique dispositi, 155-185  $\times$   
17.2-19.4  $\mu$ . Paraphyses et periphyses nullæ,  
Ascosporæ hyalinæ vel sub-hyalinæ, parietibus  
duplicibus ornatae, uniseptatae, alte constrictæ  
ad septa, ovoideæ, rotundatae ad utrumque  
apicem, 21.5-28  $\times$  13-15.5  $\mu$ .

Incitat maculas piceas in *Syzygio jambolano*  
DC. viventi; leg. S. Ananthanarayanan in loco  
Mahableshwar in India mense Januario 1962  
and 1963, M.A.C.S. Herb. No: 164. (type):

The type is being deposited at the C.M.I.,  
Kew, England, and is at the Herb. Crypt.  
Orientalis, New Delhi, India.

The species is described after Dr. G. B.  
Deodikar, Director, M.A.C.S., in recognition of  
his many services in the realm of Botany.

The author's thanks are due to Prof. M. N.  
Kamat for guidance, to Prof. H. Santapau for  
the Latin diagnosis, and to the University  
Grants Commission for the award of a  
scholarship.

M.A.C.S. Lab., S. ANANTHANARAYANAN.  
Poona-4, May 15, 1963.

1. Ananthanarayanan, S., "On the occurrence of *Nor-  
barklaya natalensis*, Syd.," *Curr. Sci.*, 1962,  
31 (10), 424.

2. Petrak, F., *Sydowia, Ann. Mycologici*, 1949, 3,  
241.

3. Sydow, P., *Ibid.*, 1925, 23, 341.

#### ON EGG NUMBER AND SIZE PRODUCED BY *MELOIDOGYNE* *JAVANICA*, THE ROOT-KNOT NEMATODE, ON FIVE HOST PLANTS

THE influence of host plant on egg production  
by some species of *Meloidogyne* has been  
reported by other workers.<sup>1-3</sup> In the earlier  
studies made in this laboratory variations in  
the shape and size of the root-knots produced  
by *Meloidogyne javanica* (Treub) Chitwood on  
different hosts has been reported.<sup>4</sup> To study  
the egg output of *M. javanica* as influenced by  
the host plant, five susceptible hosts, viz.,  
sugarcane, brinjal, tomato, tobacco and bhendi,  
were selected and they were inoculated under  
controlled conditions following the procedure  
adopted in the earlier studies.<sup>5</sup> All the host  
plants were inoculated on the same date, using  
equal quantities of the inoculum. On the 45th  
day after inoculation, 25 egg-sacs from each of  
the affected hosts were picked out at random.  
The eggs were separated from the mucoid egg-  
sac by soaking in 3% H<sub>2</sub>O<sub>2</sub> for 20 minutes,  
followed by washing in distilled water and then  
transferring to 1% NaCl solution in cavity  
slides.<sup>6</sup> In about 48 hr. the eggs got slowly  
released from the sac. The total number of  
eggs from each sac was then counted and from  
each host 25 sacs were counted and recorded.  
The results were statistically analysed to  
examine the significance of differences between  
the hosts and the results are summarized in  
Table I.

A highly significant difference between the  
total number of eggs in the sacs formed in  
sugarcane roots and those of others was indi-

cated. Between tomato, tobacco, brinjal and bhendi, there was no significant difference in this regard.

TABLE I

A comparison of egg output in different hosts by *Meloidogyne javanica*

	Sugarcane	Brinjal	Tomato	Tobacco	Bhendi
Total No. of eggs in 25 sacs	2483	4066	4647	4191	5156
Range ..	56-234	57-374	76-401	97-320	87-346
Average ..	99.3	162.6	185.9	167.6	206.2

Significant at 1% level: S.E. 13.53. L.S.D. 49.23.  
Significance: Bn Tm Tb Br S

Bn = Bhendi; Tm = Tomato; Tb = Tobacco;  
Br = Brinjal; S = Sugarcane.

In order to examine the size of eggs produced by the nematode on different hosts 100 eggs from each host were measured for their length and breadth under a microscope. The breadth of eggs from the five hosts measured almost identically, i.e., 31 to 40  $\mu$ . But there were differences in the lengths of eggs produced on different hosts (Table II). The eggs formed on tomato and brinjal were longer than those formed on the other three hosts.

TABLE II

A comparison of egg length in different hosts produced by *Meloidogyne javanica*  
(100 eggs measured under each treatment)

	Sugarcane	Brinjal	Tomato	Tobacco	Bhendi
Range of length	72-96	72-108	72-96	72-96	72-96
Average	83.40	87.24	87.84	83.40	83.16

Significant at 5% level: S.E. 14.88. L.S.D. 27.13.  
Significance: Tm Br S Tb Bh

Tm = Tomato; Br = Brinjal; S = Sugarcane  
Tb = Tobacco; Bh = Bhendi.

The results obtained in the present studies indicate that the egg output and length, but not the breadth, are influenced by the host plant. *M. javanica* being an internal parasite lives mostly inside the host tissue and is therefore influenced by several physiological and nutritional conditions of the host plant<sup>1,3,7-8</sup> which might cause such variations in egg production.

Microbiology Lab., M. BALASUBRAMANIAN.  
Dept. of Agriculture, G. RANGASWAMI.  
Annamalai University,  
Annamalainagar, September 17, 1963.

1. Tyler, J., *Proc. Helmin. Soc. Wash.*, 1938, 5, 49.
2. Oteifa, B. A., *Phytopathology*, 1953, 43, 171.
3. Maung, M. O. and Jenkins, W. R., *Plant Dis. Repr.*, 1959, 43, 791.
4. Rangaswami, G., Balasubramanian, M. and Vasantharajan, V. N., *Curr. Sci.*, 1961, 30, 149.
5. —, Vasantharajan, V. N. and Venkatesan, R., *Ibid.*, 1960, 29, 236.
6. Dropkin, V. H., Martin, G. C. and Johnson, R. W., *Nematologica*, 1955, 3, 115.
7. Tarjan, A. C. and Hooper, B. E., *Plant Dis. Repr.*, 1953, 37, 313.
8. Jones, F. G. W., *Plant Pathology Problems and Progress, 1908-1958*, Univ. Wisconsin Press, Madison, U.S.A., Pp. 395.

### A NEW CATERPILLAR PEST OF JOWAR EARHEADS

*Euproctis subnotata* Walker (Lymantridae, Lepidoptera) occurred as a new grain-cutting pest of jowar earheads (*Sorghum vulgare* Pers.). A large number of tussock caterpillars was found inside the earheads damaging the hardened grains in the khariff jowar crop extending over 50 acres in the college farm during October-November 1962. First the caterpillars were observed in the early maturing exotic varieties (Dwarf 16589 in the Accelerated Hybrid Sorghum Program of the Rockefeller Foundation), but soon after they took to the local varieties as well.

Except *E. xanthorhoea* Koll., which was noted by Fletcher,<sup>4</sup> there have been no previous records<sup>1-4,6-9</sup> of Lymantrid caterpillars infesting jowar earheads.

#### GENERAL DESCRIPTION OF THE STAGES

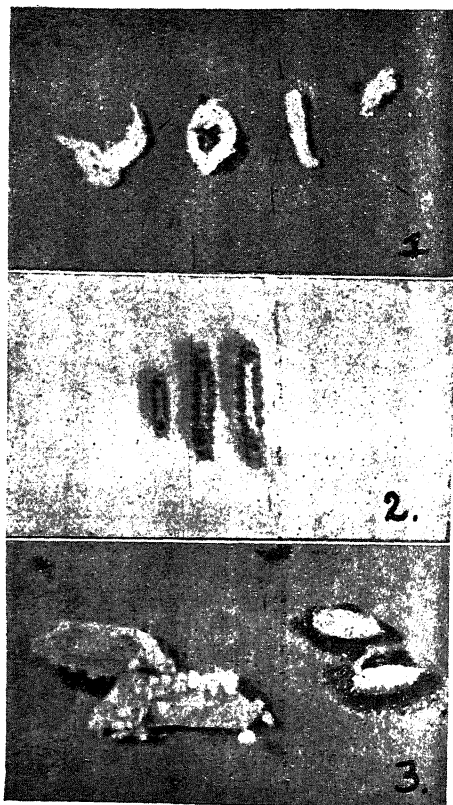
**Moth.**—Head yellow; proboscis aborted; antennae bipectinated in both sexes; thorax brown; forewing brown with dark scales, which colour extends as two spurs across the yellow marginal area below the apex and to the centre of the margin; hind wing yellow; legs clothed with woolly hairs; abdomen brown with dark transverse bands between segments, the anal tuft of hairs orange-yellow in both sexes, very elaborate in the female.

**Larva (Full-Grown).**—Head honey-yellow with brown speckling in elongate patches anteriorly along the epicranial suture. Body brown, a wide yellow band dorsally on abdominal segments 1 to 7 and 9 with a median orange-red line all along the yellow band; a fine yellow band on each side above the sub-spiracular line connecting the red verrucæ from the mesothorax to abdominal segment 9. Thoracic legs yellow and well developed; prolegs four pairs on abdominal segments 3 to 6 and an

anal pair, yellow with brown and orange-red patches, crochet uniordinal in a penellipse. Abdominal segments 6 and 7 each with a pale yellow medio-dorsal eversible gland. The body setæ are borne on verrucæ except fine setæ on the prolegs. The setæ are finely plumose, black above and gray laterally.

*Pupa*.—Typically obtect adecticous; characterised by the presence of scars of the larval verrucæ on the adominal segments. The pupæ are enclosed in silken cocoons containing urticating hairs.

*Egg*.—Spherical, transparent white, laid in masses and covered by orange-yellow hairs from the anal tuft of the mother.



FIGS. 1-3.

*Some Notes on Life-history (Figs. 1-3).*—Egg masses (6 to 24 eggs in each) are laid on the jowar earheads. The newly hatched larvæ have a congregating habit, which continues even in grown-up larvæ, and as many as 47 to 193 caterpillars may be present in an earhead. They feed together and cut the hardening grains; but considering the number of the caterpillars found in an earhead, the damage caused to the grain is slight. Pupation occurs

on the ground and also in the earheads and 4 to 27 cocoons may be found in an earhead. Egg, larval and pupal stages last 5-7, 13-43 and 10-17 days respectively. Only one generation of the pest has been observed on the jowar earheads during the last kharif season.

10% DDT or 1% parathion dust gives effective control of the pest. Grain dusted with parathion may be used for consumption 3 weeks after treatment, and DDT may be dusted to seed grain.

Grateful thanks are due to Dr. S. W. Mensinkai, Principal, for facilities and encouragement. Thanks are also due to the Director, Commonwealth Institute of Entomology, London, for confirmation of the identity of *E. subnotata*.  
College of Agriculture, S. USMAN.  
Dharwar, March 20, 1963.

1. *Crop Pests and How to Fight Them*, Directorate of Publicity, Government of Maharashtra, Bombay, 1960, pp. 36-46.
2. Ayyar, T. V. Ramakrishna, *Handbook of Economic Entomology for South India*, Government Press, Madras, 1940, pp. 171-82.
3. David, B. V. and David, S. K., *Madras Agri. J.*, 1961, 48(3), 93.
4. Fletcher, T. B., *Agri. Res. Inst. Pusa Bull.*, 1921, 100, 1.
5. Gardner, J. C. M., *Ind. For. Rec. (V.S.)*, 1938, 3 (10), 187.
6. Katagihallimath, S. S., *Coll. of Agri. Dharwar Mag.*, 1962, 15, 45.
7. Tirumal Rao, V., *Indian J. Ent.*, 1956, 18, 123.
8. Trehan, K. N. and Pingle, S. V., *Jour. Bom. Nat. Hist. Soc.*, 1946, 46, 139.
9. Putta Rudriah, M., *Sasyarakshanti Pustakamala* 2, (In Kannada), Mysore Agric. Dept. Pub., 1955.

#### PAPAYA DECLINE DISEASE INCITED BY NEMATODES IN MAHARASHTRA

LARGE-SCALE cultivation of papaya in Maharashtra has become a problem in recent years due to serious diseases. Many of the plantations have been wiped out with a disease showing gradual decline of vigour of the trees and ultimate death. Capoor and Varma<sup>1</sup> reported the occurrence of mosaic virus disease in Poona transmitted by several aphids such as *Aphis gossypii* Glover, *A. malvac* Koch, *Myzus persicae* Sulz and others. The main symptom of the disease is development of yellowish-green patches on the leaves with blister-like green tissue. Since the older leaves are shed there is only a small crown of younger leaves at the top appearing like witchesbroom as also noted by Parris<sup>2</sup> in a similar disease on papaya in an island in Hawaii (Fig. 1) and by Garga<sup>3</sup> in M.P. Such plants show very poor bearing and

die prematurely. Capoor and Varma<sup>1</sup> reported successful transmission in seedlings by sap inoculation which did not prove successful in the case of the papaya disease in M.P.S and recommended eradication of all diseased trees as a control measure. This eradication was supposed to remove the source of inoculum for insect transmission. Since their large-scale experiments with spraying insecticides over 20 acres did not give any effective control, the further line of work that they have taken up at the moment is to obtain hybrids with the wild *Carica cauliflora*, a Venezuelan species, with large leaves and fruits of the size of a tomato, which was reported to be virus-resistant by Vacudeva,<sup>2</sup> thereby making the problem of control a matter of speculation.

Investigated. Detailed studies soon indicated that all these plants with symptoms of papaya mosaic showed a severe root rot, the main feeding roots being killed. This occurred both in nursery seedlings and in the large trees. When a large tree showing such a symptom was pushed, the basal trunk portion, above the soil level, broke down and collapsed. The core of the basal stem tissue had become brown and spongy. Microscopic examination of more than 200 trees and young plants with mosaic symptom showed the same root rot infection and the disease inciting organism was found to be nematodes (Fig. 2). 5 mg. of these diseased stem tissues showed not less than 500 to 1000 nematodes, which were found to belong to parasitic group.



FIGS. 1-3. Fig. 1. Diseased papaya showing a crown of small leaves on the spindling top. Fig. 2. Nematodes in the macerated brown tissue of the basal stem. Fig. 3. Diseased papaya produced by inoculation with nematodes. A small seedling by its side has collapsed. Uninoculated plant of the same age for comparison.

In studying a large number of papaya in plantations, Government gardens and privately owned estates, the plants, showing identical symptoms reported by Varma and Capoor were

Following these observations, inoculation experiments were undertaken to prove the pathogenicity of these nematodes. Papaya seedlings were raised in pots with sterilized

soil and when the plants were 2' high, fresh nematode inoculum taken from the spongy mass of the diseased papaya trees was macerated and added to the soil at a depth of 3". 10 plants were inoculated with the nematode and equal number of plants were kept as control. Observations showed that within 35 to 45 days all the inoculated plants showed the typical chlorotic patches on the leaves like the virus symptoms reported by Capoor and Varma. The lower leaves were shed, and about a month later there were only few small leaves on a weak stem which was lanky and spindling at the top (Fig. 3). The inoculated plants died after 2 to 3 months. These experiments were repeated on a large scale on plants of different ages with the same results. In the absence of addition of nematode inoculum, the control plants remained completely healthy and no visible symptoms of mosaic were seen though plants were kept exposed in the open.

These studies open up a new problem whether the serious disease of papaya in Maharashtra is not mainly a nematodes disease. The mosaic which may be transmitted by aphids may cause a mottle not connected with the decline and death of trees. The aphids reported as vectors do not colonise on papaya and this has been reported by Capoor and Varma also. The papaya decline disease reported herein as being due to nematodes has the same status like that of peach re-planting problem in Canada reported by Koch.<sup>4</sup> Whether the nematode causes disease by toxin secretion as was found to be the case in the Peach disease by Mountain and Patrick<sup>5</sup> or transmits a virus as in the case of fan-leaf of grape reported by Hewitt *et al.*<sup>3</sup> is a problem for future investigation. The immediate method of control of the disease appears to be one requiring large-scale application of nematocides. The wilt of betel-vine in Maharashtra due to nematodes is another such instance.

The investigation was mainly carried out at home in Poona. Certain facilities given at the M.A.C.S. Laboratory, Poona, are thankfully acknowledged.

Malleswaram,  
Bangalore-3,

M. J. NARASIMHAN.  
T. V. SUBRAMANIAM.

November 8, 1963.

1. Capoor, S. P. and Varma, P. M., *Curr. Sci.*, 1948, 17, 265.
2. — and —, *Ind. Phytopath.*, 1961, 14, 96.
3. Hewitt, W. B., Raski, D. J. and Goheen, A. C., *Phytopath.*, 1958, 48, 586.

4. Koch, W., *Canad. J. Bot.*, 1955, p. 33.
5. Mountain, W. B. and Patrick, J. A., *Ibid.*, 1959.
6. Parris, C. K., *Hawaii Agri. Exp. St.*, 1938, 36, 263.
7. Vasudeva, R. S., *Commonwealth Phytop. News*, 1959, 5, 59.
8. Garga, R. P., *Ind. Phytopath.*, 1963, 16.

### POLLEN PRODUCTION IN SOME ALLERGENIC PLANTS

ALTHOUGH aeropalynological surveys have been done at various places in India,<sup>1-5</sup> such data have not been supported by pollen production studies of the plants producing atmospheric pollen. In the present study pollen production per flower of some allergenic plants of Lucknow<sup>3</sup> has been made as the density of dispersion of the various pollen types in the air at a given area is conditioned by several factors such as plant habit and distribution of the various plants.

In making pollen counts, unopen flowers are collected, from which one anther or a measured portion of an anther is crushed, dispersed uniformly in a measured quantity (50 drops) of dilute glycerine contained in a glass centrifuge tube. From the dispersion a drop is transferred to a slide and covered with a cover glass. From the number obtained in one drop of dispersion, the relevant calculations for the whole anther and for one flower are made. The palynological data are presented in Table I.

TABLE I

Pollen production in some allergenic plants of Lucknow

Plant name	No. of anthers	Production per flower	No. per anther
<i>Amaranthus spinosus</i>	5	4136	827
<i>Argemone mexicana</i>	70	185500	2650
<i>Asadirachta indica</i>	9	1900	211
<i>Botriochloa pertusa</i>	3	97	32
<i>Cedrela toona</i>	5	6500	1300
<i>Chenopodium album</i>	5	666	133
<i>Morus alba</i>	4	93550	23388
<i>Salmelia malabarica</i>	66	2772000	42000
<i>Holoptelea integrifolia</i>	7	59500	8500
<i>Xanthium strumarium</i>	5	5283	1056

As evident from Table I, the largest pollen production is in *Salmelia malabarica* and the lowest in *Cedrela toona*. Although *Salmelia* is a high producer, aeropalynological data<sup>3</sup> have shown its very poor representation, possibly due to the scarcity of their occurrence in Lucknow, or may have been conditioned by the density of the grains. On the other hand, *Holoptelea integrifolia*

*folia* has been found to occur in such great abundance in the air as to eclipse all other sporomorphs, because of their anemophilous nature (pollen being loose, scantily sculptured, small), and the abundance of those plants in Lucknow. Similarly, *Botriochloa pertusa* producing only 32 grains per anther is not of minor significance, because the occurrence of the herb, as also of other grasses, in enormous numbers during specific periods.

The authors are thankful to Prof. K. N. Kaul for his interest in the work.

Palynology Laboratory, P. K. K. NAIR.  
National Botanic Gardens, K. RASTOGI.  
Lucknow, May 3, 1963.

1. Kalra, S. L. and Dumbrey, D. G., *Armed Forces Med. J. (India)*, 1957, **13**, 3.
2. Sanghvi, L. M., Sethi, J. P. and Kasliwal, R. M., *J. Indian Med. Ass.*, 1957, **29**, 43.
3. Lakhanpal, R. N. and Nair, P. K. K., *J. sci. industr. Res.*, 1958, **17 C**, 80.
4. — and —, *Ibid.*, 1960, **19 C**, 51.
5. Shivpuri, D. N., Viswanathan, R. and Dua, K. I., *Indian J. Med. Res.*, 1960, **48**, 15 and 21.

#### SOME NEW RECORDS OF ZYGNEACEAE FROM INDIA AND PANJAB

THE communication deals with eight forms, collected from some low-lying areas along the G.T. Road, between Subhanpur and Dhillwan, District Kapurthala, a distance of five miles, during November 1961 to April 1962, and in September 1962. Of the eight forms, five are new records for India and three for Panjab.

1. *Mougeotia floridana* Transeau. *Trans. Amer. Micros. Soc.*, 53, 12, 224, 1934; Randhawa, *Zygnemaceae*, p. 154, f. 74, 1959.

This is a new record for Panjab. Rattan's algal collection No. A-2.

2. *Spirogyra irregularis* Nageli. In Kutzing, *Species Algrum*, 440, 1849, also *Tab. Phycol.*, 5, Pl. 23, 2, 1855; Randhawa, p. 360, f. 290, 1959.

This is a new record for India. Rattan's algal collection No. 208.

3. *Spirogyra minor* (Schmidle) Transeau. *Ohio Jour. Sci.*, 44, 243, 1944; Schmidle, 1901, Randhawa, pp. 336-37, f. 332, 1959.

This is a new record for Panjab. Rattan's algal collection No. 200.

4. *Spirogyra paradoxa* Rao, *J. Indian bot. Soc.*, 16, 281, f. 5-E, 1937; Randhawa, pp. 326-27, f. 313, 1959.

This is a new record for Panjab. Rattan's algal collection No. 201.

5. *Spirogyra pulcherrigurata* Jao. *Sinensia*, 6, 601, Pl. 8, f. 91, 1937; Randhawa; pp. 334-35, f. 328, 1959.

This is a new record for India. Rattan's algal collection No. 203.

6. *Spirogyra pratensis*, Transeau. *Amer. Jour. Bot.*, 292, 1914; Randhawa, pp. 297-98; f. 257, 1959.

This is a new record for India. Rattan's algal collection No. 207.

7. *Spirogyra reinhardi* Chmielevski. In Borge's *Susswasserflora Deutschland*, 9, 31, f. 41, 1903; Randhawa, p. 373, f. 406, 1959.

This is a new record for India. Rattan's algal collection No. A-2.

8. *Spirogyra wollnyi* de Toni. *Sylloge Algarum*, 2, 754, 1889; Wollny, *Hedwigia*, p. 166, 1887; Randhawa, p. 417, 1959 (Fig. 1).

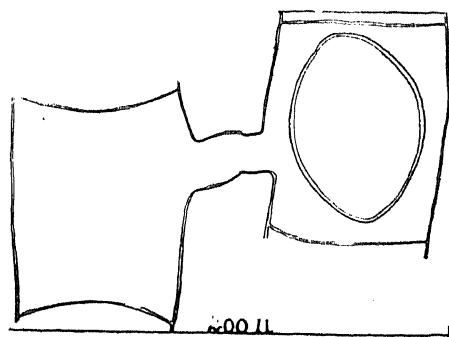


FIG. 1. *Spirogyra wollnyi*

This is a new record for India. Rattan's algal collection No. 207.

I am very highly indebted to Dr. G. S. Venkataraman, Ind. Agric. Res. Inst., New Delhi, for guidance and to Dr. M. S. Randhawa for interest.

Ripudaman College,  
Nabha, February 18, 1963.

R. S. RATTAN.

1. Randhawa, M. S., *Zygnemaceae—A Monograph*. Publ. Indian Council of Agricultural Research, New Delhi, pp. 478.

---

 REVIEWS
 

---

**Geometrodynamics** (Vol. I)—*Topics in Modern Physics*—A series of monographs sponsored by the Italian Physical Society. By J. A. Wheeler. (Academic Press, New York and London), 1961. Pp. xvi + 334. Price \$ 6.50.

Geometry entered Physics in a big way when Minkowski rewrote the equations of the special theory of relativity in the formalism of a 4-dimensional geometry. The field equations of the general theory of relativity were formulated against the background of the space-time continuum, the gravitational field determining the curvature of the continuum. But even at that stage nobody suspected that the "Arab-Camel episode" will be enacted in Science and that Geometry will come forward with a claim to replace Physics! Geometrodynamics asserts that Physics is Geometry; the fields and particles of Physics are nothing else but the ripples and warpings of the 4-dimensional Riemannian manifold, which we call space-time. How did this come about? Are all the tall claims of Geometrodynamics realised? What are these claims and what are its expectations? These are some of the problems discussed in great detail (geometrical as well as physical) in this book.

The foreword to this book begins in this manner: "This is a collection of papers dealing with Geometrodynamics. Geometrodynamics is the study of the geometry of curved *empty* space and the evolution of this geometry with time according to Einstein's standard 1916 general relativity. The sources of curvature of space-time are conceived differently in geometrodynamics and in usual relativity theory. In the older analysis any warping of the Riemannian space-time manifold is due to masses and fields of non-geometric origin. In geometrodynamics—by contrast—only those masses and fields are considered which can be regarded as built out of geometry itself. This subject can be considered to date from the period 1955-57 when it was discovered that mass and electricity can be fashioned out of curved empty space."

Professor Wheeler has an excellent style of presentation in which he first gives a very comprehensive qualitative description of the principal results in an introductory section which may be a fairly large section. This will be followed by detailed mathematical derivation

of the results. Since the motivation for the mathematics is already known from the introductory section it becomes easier to follow the mathematical derivation. This will be followed by conclusions and discussion of any loose ends which might have been left uncovered. This is the general style in which each of the four papers which are collected in this book is written. Not only that but the order in which these four papers are arranged in the book also follows this general pattern. The first paper gives a general survey of the present state of knowledge in Geometrodynamics including its problems and prospects. Next three papers are the following well-known papers by Prof. Wheeler and his collaborators which laid the foundation of this new branch of Physics:

- I. "Geons": J. A. Wheeler, *Phys. Rev.*, 1955, 97, 511-36.
- II. "Thermal Geons": E. A. Power and J. A. Wheeler, *Rev. Mod. Phys.*, 1957, 29, 480-95.
- III. "Classical Physics as Geometry": C. W. Misner and J. A. Wheeler, *Ann. Phys.*, 1957, 2, 525-660.

These papers have long been out of reach and hence their reproduction in the book form is very welcome.

Beginnings in *Geometrodynamics* were made by Rainich (1925) when he showed that the scheme of Einstein-Maxwell's equations could be worked backwards. Given an electromagnetic field Einstein-Maxwell equations give the curvature of the resulting curved space-time. Rainich showed that under certain conditions (known as Rainich conditions) given a curvature of space-time one can always associate a charge-free electromagnetic field with it. Thus he "created" an electro-magnetic field out of the geometry of the Riemannian 4-space. One can now look upon Einstein's general relativity as giving a scheme which "creates" a mass-free gravitational field out of geometry. In order to establish Geometrodynamics as a branch of Physics, it was further necessary to "create" masses and charges out of the geometry. This was done by Wheeler and his collaborators in 1955-57 and the results of these investigations are described in the last three chapters of this book.



In the first chapter which is entitled, "Neutrinos Gravitation and Geometry", in addition to the general survey of Geometrodynamics, the author poses this question: "Does there exist a purely geometrical description of the neutrino field?" and finds that it is not at present possible to point to a natural and a decisive connection between a spinor field and geometrodynamics. Therefore in the rest of this chapter a description of the neutrino field in a pre-existing curved space-time is given as discussed by Feynman (1948) and Klauder (1960). Any body who is interested in the common thread which runs through diverse fields of knowledge like physics of fundamental particles, gravitational fields and cosmology, Riemannian Geometry and the theory of homology groups, will benefit considerably by going through the pages of this book.

P. C. VADYA.

1. Feynman, R. P., *Rev. Mod. Phys.*, 1948, 20, 367.
2. Klauder, J. R., *Ann. Phys.*, 1960, 11, 123.
3. Rainich, G. Y., *Trans. Am. Math. Soc.*, 1925, 27, 106.

**Hydrodynamic Superposability.** By Ram Ballabh. (Asia Publishing House, Bombay-1), 1963. Pp. 45. Price not given.

The present monograph deals with the hydrodynamic superposability and includes the following eight topics: (i) Definition of superposability, (ii) Some general properties of superposable flows, (iii) Beltrami flows defined by  $\text{curl } q = \lambda q$ , (iv) Beltrami flows with  $\lambda$  constant, (v) Superposability of two Beltrami flows, (vi) Steady, uniplanar superposable flows in non-viscous fluids, (vii) Superposability and self-superposability of two-dimensional flows, and (viii) Superposability and self-superposability of axi-symmetric flows.

In a practical problem there always appear rigid boundaries and the consideration of the superposability of solutions of Navier-Stokes equations, when it is possible, helps one in constructing a general solution for the problem. However, the entire monograph deals with the superposability of fluids of infinite extension in all directions with the neglect of rigid boundaries.

Among the Indian contributions the author refers only to the work done by himself and his colleagues. It is satisfying to note that some important results obtained by other workers have been incorporated though without specifically referring to those investigations.

This booklet has been published as a Uttar Pradesh Scientific Research Committee monograph and has been written in a clear and lucid manner.

P. L. B.

**Comparative Biochemistry—A Comprehensive Treatise (Vol. IV).** Part B. *Constituents of Life*. Edited by M. Florkin and H. S. Mason. (Academic Press, Inc., New York-3), 1962. Pp. xxiii + 841. Price \$ 26.00.

The book under review is the fourth volume of the series "Comparative Biochemistry" and contains fifteen articles written by experts in their respective fields. It begins with a comprehensive and lucid discussion by Ulbricht on the optical asymmetry of metabolites with special emphasis on D-amino-acids and their role in proteins. This is followed by two chapters on carbohydrates, one by Brimacombe and Stacey on cellulose, starch and glycogen and the second on the biochemistry of lignin formation by Nord and Schubert. In the fourth chapter on nucleic acids, Brawerman and Shapiro have given an extensive review of the literature on the subject. However, in the section in cellular localization of the nucleic acid, the authors have failed to mention the presence of cytoplasmic DAN (Kappa cells) in certain species of *Paramecia*.

In dealing with protein molecules, Vegotsky and Fox have given an excellent account of a comparative structural study of various proteins, including enzymes and hormones. The structural similarities of pancreatic enzymes and hormones have not, however, been discussed in detail. Henderson, Gholson and Dalglish have a chapter on metabolism of aromatic amino-acids, and this is followed by a series of three articles on (i) Structure and chemical properties of Keratin-forming tissues, (ii) Sclerotization and (iii) Silk and other cocoon proteins. The article on blood coagulation deals very comprehensively with a comparative account of this biological process in various species. Similarly, Bennett and Frieden have dealt with every aspect of metabolic changes during metamorphosis in their lucid article on biochemical adaptation in amphibia.

The essay on 'Porphyrins' by Rimington and Kennedy is really very fascinating to read. As the authors state the porphyrins "have an importance far greater than their ornamental qualities". These compounds have been utilised by the living cell to provide the most indispensable catalysts for all but the very lowest

forms of living matter. In a similar style Forrest and Goodwin treat the comparative study of biochemical and structural aspects of pteridines and carotenoids, respectively. The last chapter on comparative biochemistry of the alkali metals by Steinbach gives an exhaustive account of the biochemical, physiological and pharmacological aspects of alkali metals in the living body.

The challenging task of compiling and editing the articles on various aspects of comparative biochemistry has been well executed by the editors Florkin and Mason. However, topics such as vitamins, bacterial viruses are conspicuous by their absence in the present volume. But the critical and comprehensive nature of the articles presented by well-known authorities should make this a welcome addition to the book-shelf of every research worker in biochemistry and allied sciences.

P. S. SARMA.

---

**International Review of Experimental Pathology** (Vol. I). Edited by G. W. Richter and M. A. Epstein. (Academic Press, London), 1962. Pp. 453. Price \$ 15.00.

The *International Review of Experimental Pathology* aims at providing an integrated account of advances made by investigators of different disciplines, on current problems of experimental pathology.

The subjects selected are of special topical significance. The presentation is very lucid and the coverage is much wider than implied by the term experimental pathology and includes the contributions from the fields of genetics, biochemistry, biophysics and nuclear biology.

Immunology cannot progress without a clear understanding of the 'Genetics and biochemical processes involved in the lymphopoiesis and plasmocytopenesis'. 'Genetics of antibody products' emphasizes this aspect and deals with the role of the plasma cells and lymphocytes in the production and distribution of antibodies, the molecular genetics of immune responses and the associated problems of immunological tolerance, immunological paralysis, transplantation and auto-immunity.

With the aid of 'Electron microscopy' conspicuous progress has been made in research on the renal glomerulus. The 'Ultra structure of glomerular lesions' reveals the existence of mesangial cells, depicts the fine cellular structure and discusses the various functions of the glomerular cell components.

The relation of radiation dysplasia to radiation neoplasia, the environmental factors essential for the development of Carcinoma and the nature of the tissue at risk in irradiation of the bone are some special features discussed at length in the comprehensive review 'Bone disease induced by radiations'. The other chapters, 'Experimental histogenesis' and 'Arteriolar hyalinosis', deal with the advances in the relatively little explored fields of tissue formation and the histochemistry of hyaline substances respectively.

M. SIRSI.

---

**Newer Methods of Nutritional Biochemistry with Applications and Interpretations.**

Edited by Anthony A. Albanese. (Academic Press, New York and London), 1963. Pp. xi + 583. Price \$ 18.50.

Rapid progress in our understanding of the multi-disciplined science of nutrition has been made possible by advances in methodology and techniques of experimentation based on physical, chemical and biological principles. This book is intended to be a disussion of such newly developed or improved methods which have their applications in some of the currently most active areas of nutrition research. Five chapters relate to proteins and amino-acids, assessment of their efficiency, intestinal absorption, turnover and relationship to tissue enzymes. Two others deal with some of the B vitamins and ascorbic acid. The metabolism of carbohydrates, fats and minerals are each detailed in separate chapters and the concluding one is devoted to general principles about design of biological experiments and statistical procedures for analysis of collected data.

The different chapters are each written by established investigators in the respective areas covered. Necessarily, there has been a lack of uniformity in the approach to the subject-matter of the book and while some authors have dealt with methodology and analytical procedures systematically alongside of nutritional aspects, others have merely reviewed certain recent developments with inadequate attention to a discussion of related techniques. In a few instances, the topics chosen and dealt with are somewhat arbitrary and even restricted in scope.

While, therefore, the specialised research worker may not always find the publication serving his needs, it will be a useful aid to the graduate student in his understanding of the scope that exists for the application of the discoveries of bio-organo-physical chemistry to

study of nutritional problems of current interest and importance.

The extensive citations to original literature, together with the author and subject indices, add to the usefulness of this volume.

A. S.

**Advances in Agronomy** (Vols. 13 and 14).

Edited by A. G. Norman, (Academic Press, New York), 1961 and 1962. Pp. xi + 386; Pp. xi + 432. Price \$12 and \$13.

The two volumes refer to the series which include reviews by eminent agronomists of research progress in soil and crop science and developments in agronomic practices. The definition of agronomy adopted here is as in American usage and not in its restricted sense adopted in Europe and hence the subjects reviewed cover a wide field.

Vol. 13 has 8 chapters of which "The Podzol and Podzolic Soils", "Physical Chemistry of Clay-Water Interaction" and "Iron Chlorosis in Plants" refer to studies on soils. The chapter "Stubble Mulch Farming" discusses the practice of tillage of soils without inversion and the maintenance of crop residues on the soil surface with reference to its effect on soil erosion, moisture retention in the soil, increased yields of wheat, nitrate formation in the soil, effect of soil temperature and protein content in the wheat grain.

The chapter on "Subterranean Clover", an Australian species, is a comprehensive study of the plant, including its taxonomy, ecology, physiological variation, nodulation and fixation of nitrogen, agrotechniques, diseases and pests affecting the crop and its agronomic improvement by breeding and concludes with its potential usage in Australia and elsewhere.

A chapter on "The Barley Yellow Dwarf Virus disease of small grains" (BYDV) summarizes the current knowledge about this virus, and examines this knowledge critically in the light of accumulated experience of many workers with aphid-transmitted viruses of other crops. Oat and barley are the small grains most severely affected by the disease, and although wheat and rye are also susceptible to the virus, they appear to have more tolerance to infection. At least 84 species of grass are subject to infection showing that the virus has an extensive host range among grass species.

A small chapter on "Contamination of Soils by Petroleum Hydrocarbons" discusses the drastic changes in microbiological, chemical and physical properties of the soil as a result of

contamination by crude oil and natural gas. "The Abundance of earthworms in agricultural land and their possible significance in agriculture" deals with the quantitative effect of the action of earthworms in incorporating and helping in the decomposition of organic matter and keeping the soils open and porous on productivity of the soil. The conclusion reached as a result of pot cultures is that earthworms can bring about a number of changes that benefit plant growth, and trials in New Zealand suggest that in some places the earthworms can increase productivity in the field.

Vol. 14 has also 8 chapters which include one on "Laterite" and another on "Rainfall Erosion".

The chapter on "Rice Improvement and Culture in U.S.A." is a comprehensive account of rice culture and the present position of improved varieties developed at the research stations, their distribution and production. The general objectives of rice improvement are mentioned and attention is drawn to some special investigations, such as breeding for virus resistance and breeding for special grain quality.

There are two chapters dealing with Soyabean, one on its genetics and breeding and the other on its agronomic management. The chapter on "Isotope method and uses in Soil Physics Research" discusses isotopes methods for investigating, (1) Soil water, (2) Soil air, (3) Soil impedance to root growth and (4) Soil temperature. Though the use of isotopes in soil physics research and practice is still in its infancy, the review in conclusion suggests what particular lines of work could prove valuable.

Two chapters one on "Fertilizers and the Efficient Use of Water" and the other on Evaluation of Fertilizers by Biological Methods" are of special interest to agronomists. The first surveys the current state of knowledge on the effects of fertilizers on the evapotranspiration of plants and the efficiency with which that water is used in dry matter and salable crop production. All evidence indicates that dry matter produced per unit of water used can be greatly increased if fertilizers increase yield. So fertilization for the adequate nutrition of all crops plays a major role in the efficient use and conservation of water resources. Fertilizers can also increase root development within the soil so that soil water is used to higher tensions and at greater depths.

The chapter on "Biological Evaluation of Fertilizers" discusses (1) the relationship between the chemical properties of fertilizers and

reactions which occur in the soil; (2) the significance of soil-fertilizer reaction products to crop uptake of nutrients; and (3) some of the principles and practices involved in evaluating fertilizers. Because of the increasing number and complexity of fertilizers commercially available, there is need for evaluating fertilizers. It is suggested that in evaluation research in addition to field trials increasing use of laboratory and plant house pot methods should be made. It is also stated that extension of research on explaining differences in limiting yields among fertilizers, and methods for measuring differences in residual effects of fertilizers, should be worthwhile.

The chapters in the two books, besides providing up-to-date information on the various topics, include a comprehensive list of references. There is no doubt that these publications should prove highly valuable reference books to research agronomists engaged in the problems.

K. R.

**Organic Chemistry ; Physical Chemistry ; Inorganic Chemistry** (2nd Edition). By Wood and Holliday. (Butterworths, London W.C. 2), 1963. Pp. xxiv + 349 ; xi + 346 ; xi + 415. Price 21 sh. each.

The first edition of this trio of books by Wood and Holliday published in 1960 was reviewed in these columns in July 1961 (see *Curr. Sci.*, 1961, 30, 277). That a second edition is appearing within three years of the first publication shows how well these books have been received.

In the new edition although there are no major changes in the subject-matter, the occasion has been used to add some new items of importance as for example hydroboration and petroleum analysis in organic chemistry, idea of oxidation states in physical chemistry and new compounds such as the rare gas compounds and sulphur tetrafluoride in inorganic chemistry.

Another welcome feature is the inclusion of examination questions at the end of almost each chapter.

As an introduction to the degree courses in the Indian universities, this 'trio' is strongly recommended.

**Interfacial Phenomena** (2nd Edition). By J. T. Davies and E. K. Rideal. (Academic Press, Inc., New York-3, N.Y.), 1963. Pp. xiii + 480. Price \$ 15.00.

The first printing of this second edition of *Interfacial Phenomena* by Davies and Rideal

dealing with the fundamental aspects of interfacial phenomena and their latest developments came out in 1961 and was reviewed in this Journal (see *Curr. Sci.*, 1962, 31, 252).

In this second printing small additions have been made to the sections on damping of waves on ripples (pp. 269-73) and the circulation within moving drops (pp. 335-36), bringing these topics more up to date.

**Proceedings of the Eastern Theoretical Physics Conference.** Edited by M. E. Rose. (Gordon and Breach, 150, Fifth Avenue, New York-11, N.Y.), 1963. Pp. viii + 462. Price \$ 5.00.

It has become a fashion nowadays to hold conferences on particular topics of scientific interest for which workers concerned are requested to contribute papers, and assemble for their presentation and discussion. Finally the proceedings are published in a book form for the benefit of the few who attended and the many who could not. To speed up the publication and also to make it available at a low price, the manuscripts as submitted are mimeographed with the result that their appearance in reproduction is as varied as their titles in reading.

One such is the *Proceedings of the Eastern Theoretical Physics Conference* which was held on October 26 and 27, 1962, at the University of Virginia, in which 125 physicists from Universities and research institutions in the eastern parts of the United States attended. There are 25 topics covering the subjects, Nuclear Physics, Particle Physics, and General Relativity. Giving as it does some of the latest developments in these fields, the publication will be useful to many.

A. S. G.

**Solid State Physics—Advances in Research and Applications** (Vol. 14). Edited by F. Seitz and D. Turnbull. (Academic Press, Inc., New York-3, N.Y.), 1963. Pp. xv + 519. Price \$ 16.00.

This series on *Solid State Physics*, published by the Academic Press, is well known, and each volume in the series is eagerly looked forward to by physicists, chemists, metallurgists and technologists interested in the latest developments in this important field of research.

The present volume contains the four articles : (i) *g* Factors and Spin-Lattice Relaxation of Conduction Electrons by Y. Yafet ; (ii) Theory of Magnetic Exchange Interactions : Exchange

in Insulators and Semiconductors by P. W. Anderson; (iii) Electron Spin Resonance Spectroscopy in Molecular Solids by H. S. Jarratt; and (iv) Molecular Motion in Solid State Polymers by N. Saito, K. Okano *et al.*

As was the case with previous volumes the articles in this volume are authoritative and information is fairly up-to-date and workers in their special fields will welcome this timely publication.

A. S. G.

**Schlieren Methods.** By D. W. Holder and R. J. North. *National Physical Laboratory Notes on Applied Science*, No. 31. (DSIR by HMSO, London W.C. 1), 1963. Pp. x + 106. Price 10 sh. 7 d.

In many scientific and engineering problems the events to be studied are confined to substances that are transparent colourless and non-luminous so that their observation by direct visual or photographic methods becomes difficult. Examples are the flow of air past models of aeroplane wings, problems of convection, the mixing of liquids or gases, detection of faults in optical quality glass. In such cases changes in the refractive index involved are used to investigate the problem. This is known as the Schlieren technique, because it was originally used in Germany for the detection of faults in optical glass which are often in the form of streaks (Schliere).

In the 100-page monograph *Schlieren Methods* published by the NPL various methods that are now available are explained in detail, emphasis being given to the practical aspects of the problem to be investigated. The presentation is such that even those who are not familiar with the methods will be able to assess their applicability to the problems on hand. The pamphlet contains 29 illustrative plates.

A. S. G.

## Books Received

*General Microbiology* (2nd Edition). By R. Y. Stanier, M. Doudoroff and E. A. Adelberg. (Macmillan & Co., Ltd., London W.C. 2), 1963. Pp. xiii + 753. Price 50 sh.

*Annual Review of Biochemistry* (Vol. 32). By E. E. Snell, J. M. Luck, F. W. Allen and G. Mackinney. (Annual Review, Inc., Palo Alto, Calif., U.S.A.), 1963. Pp. vii + 864. Price \$ 9.00.

*The Dithiocarbamates and Related Compounds.* By G. D. Thorn and R. A. Ludwig. (Elsevier Pub. Co., P.O. Box 211, Amsterdam), 1962. Pp. vi + 298. Price 40 sh.

*Topics in Chemical Physics.* By A. Prock and G. Mc. Conkey. (Elsevier Pub. Co., P.O. Box 211, Amsterdam), 1963. Pp. vi + 277. Price 63 sh.

*Chemical Spectroscopy.* By R. E. Dodd. (Elsevier Pub. Co., P.O. Box 211, Amsterdam C, The Netherlands), 1962. Pp. x + 340. Price £ 2-8-0.

*Bulletin of the National Institute of Sciences of India*, No. 24—Proceedings of the Symposium on Plant and Animal Viruses, held at Cuttack. (National Institute of Sciences, New Delhi-1), 1963. Pp. vi + 248. Price Rs. 13-37.

*Propagation of Radio-Waves.* By B. Chatterjee. (Asia Publishing House, Bombay-1), 1963. Pp. 114. Price Rs. 10-00.

*Color Change Mechanisms of Cold-Blooded Vertebrates.* By H. Waring. (Academic Press, New York-3), 1963. Pp. xii + 266. Price \$ 9.50.

*Fifty Years of Science Progress of Botany.* By P. Maheshwari and R. N. Kapil. Pp. vii + 178; *Progress of Mathematics.* By B. R. Seth. Pp. 44. (Indian Science Congress Association, 64, Dilkusha Street, Calcutta-17), 1963. Price not given.

*Effect of Ionizing Radiation on High Polymers.* By T. S. Nikitina, E. V. Zhuravskaya and A. S. Kuzminsky. (Gordon & Breach, Science Pub., New York-11), 1963. Pp. vi + 90. Price \$ 4.95.

*The Theory of Superconductivity.* Edited by N. N. Bogoliubov. (Gordon & Breach, Science Pub., New York-11), 1963. Pp. xii + 357. Price \$ 4.95.

*The Application of Mathematical Statistics to Chemical Analysis.* By V. V. Nalimov. (Addison-Wesley Pub. Co., Reading, Mass.), 1963. Pp. ix + 294. Price \$ 11.75.

*Rarefied Gas Dynamics* (Supplement 2). Edited by J. A. Laurman. (Academic Press, New York-3, N.Y.) Vol. I: Pp. xvi + 529. Price \$ 16.00; Vol. II: Pp. xvi + 541. Price \$ 16.00.

*Recent Progress in Hormone Research* (Vol. 19). Edited by G. Pincus. (Academic Press, New York-3, N.Y.), 1963. Pp. xiii + 750. Price \$ 22.00.

*The Cell in Mitosis.* Edited by L. Levine. (Academic Press, New York-3), 1963. Pp. xi + 274. Price \$ 10.00.

## SCIENCE NOTES AND NEWS

### Award of Research Degrees

Andhra University has awarded the D.Sc. degree in Physics to Shri V. Nagarajan for his thesis entitled "Studies on Chlorine Nuclear Quadrupole Resonance"; and Ph.D. in Physics to Shri P. Balaramarao for his thesis entitled "Studies on Drift and Anisotropy of Ionospheric Irregularities".

M.S. University of Baroda has awarded the Ph.D. degree in Zoology to Kumari A. K. Susheela for her thesis entitled "Studies on the Cellular Organisation and Metabolic Adaptation in the Mammalian Diaphragm".

### Conference on "Luminescence"

The Institute of Physics and the Physical Society, 47, Belgrave Square, London S.W. 1, announces that it is arranging a Conference on "Luminescence" to be held in the University of Hull on the 15th, 16th and 17th September, 1964. There will be a number of invited papers but offers of contributions will be welcome. Such offers should be accompanied by 3 copies of short abstracts (100-200 words) which should be sent as soon as possible and not later than 1 June 1964, to Professor G. F. J. Garlick, Physics Department, The University, Hull, Yorkshire.

It is provisionally proposed to hold sessions on the theoretical aspects of luminescence, etc., phosphor preparation, single crystal growth, organic phosphor systems, luminescent materials for lasers, etc.

Further particulars and application forms will be available in about June, 1964, from the Administration Assistant.

### Symposium on "Glycosides and Saponins"

A three-day symposium on "Glycosides and Saponins" under the joint auspices of Pharmaceutical and Drugs Research Committee, C.S.I.R., and Immunity Scientific Association, Bengal Immunity Research Institute, will be held at the latter's premises at 39, Acharyya Jagadish Bose Road, Calcutta-16, from 2nd to 4th April 1964.

The scope of the symposium covers: (1) Isolation, detection, assay and therapeutic evaluation; (2) Structural features: (a) degradative processes, (b) enzymes, and (c) structural evidences on aglycones and

sugars; (3) Pharmacological properties including structure-activity relationship; (4) Pharmacognosy, role of glycosides on plant physiology and allied subjects, and (5) Economic production of the active principles. Abstracts and full papers to be presented should reach Dr. A. N. Bose, Secretary, Immunity Scientific Association, 39, Acharyya Jagadish Bose Road, Calcutta-16, before 15th February 1964.

### Indian Science News Association

Prizes each of the value of Rs. 250 will be awarded to the authors of articles adjudged to be the best in each of the following subjects: (a) Importance of forests in the economic development of India; (b) Future of non-ferrous metals in India; (c) Use of micro-organisms in industry; (d) High power chemical fuels; (e) Importance of biology in higher secondary education in science.

Last date for submission of articles is 31st March 1964. Further particulars regarding the above 'Meghnad Saha Popular Science Prizes, 1964', can be obtained from the Honorary Secretary, Indian Science News Association, 92, Acharya Profullachandra Road, Calcutta-9.

### Occurrence of Salt-Pseudomorphs in the Vindhya

Shri R. S. Mithal, Department of Geology, University of Roorkee and G. S. Mehrotra, Central Building Research Institute, Roorkee, write:

In Bhima Series (Vindhya) of Wadi area of Mysore State (previously in Hyderabad State) some well-preserved sedimentary structures have been observed. These consist of stylolites, solution cavities, salt-pseudomorphs, rain-prints, pits and mound structures.

The occurrence of salt-pseudomorphs in upper surface of the limestones overlain by red shales is of great importance to Vindhya Geology. So far salt-pseudomorphs were reported from the Cambrians of the salt-range (Pakistan) only. Recently Prof. Misra of the Lucknow University has reported the occurrence of salt-pseudomorphs and other sedimentary structures from the upper Vindhya of Maihar-Rewah areas of Madhya Pradesh and has correlated the Vindhya with those of the salt-range of Punjab. The present discovery of similar

characters including the minor salt-pseudomorphs from the Lower Vindhya (in which the Bhima Series are grouped) confirms similar conditions of environments and deposition as those in Maihar-Rewah area. If this observation is confirmed by the detailed work (which is in progress) the stratigraphic position of the limestones of Bhima series occurring in the Mysore area may have to be reconsidered.

#### Trematoda and Trematode Diseases

Professor George Anastos, Department of Zoology, University of Maryland, writes:

A revision of Stiles' and Hassall's *Trematoda and Trematode Diseases*, Part I: Supergenera and Genera A-B by Mildred A. Doss, Collaborator, U.S. Department of Agriculture, assisted by Katharine Forsyth Roach and Virginia L. Bréen, all of the Zoology Department, University of Maryland, has just been published by United States Department of Agriculture. Part II Supergenera and Genera C including the Cercaria will be issued shortly. These publications must be used with the Index-Catalogue of Medical and Veterinary Zoology: Authors, Parts 1-18, Supplements 1-13 as the bibliographical key. Qualified persons may obtain all of these publications free of charge from the Beltsville Parasitological Laboratory, Agriculture Research Service, Beltsville, Maryland, U.S.A.

#### Occurrences of Paleocene and Eocene Beds in the Barmer District (Rajasthan)

Messrs. H. N. Siddiquie and Iqbaluddin of Geological Survey of India, 27, Chowringhee, Calcutta-13, write:

In the Barmer District, Rajasthan, the Lathi formation (Triassic to Jurassic) is followed by the Barmer Sandstone (Cretaceous) and this by the Kapurdi formation containing fuller's earth (Up. Paleocene to L. Eocene). The fossils from Kapurdi and Nagurda have been described by Barooah (*Current Science*, 1946), Glassner and Rao (*Rec. Geol. Surv. Ind.*, 1957) and Prasad (*Ind. Minerals*, 1961). Recently, Siddiquie collected clay samples from about 10 wells and auger holes in this area between Lat. 25° 45' and 26° 12' and between Long. 71° 20' and 71° 28', lying between Barmer and Sheo. *Venericardia* of *Semi-inflata* is abundant in the sample from near Rohli, while *Corbula*, *Arca*, *Lucina* and *Nuculana* are also present. The microfossils from the various samples include *Cibicides*, *Rotalia*, *Globorotalia*, *Ammonobaculites*, *Haploragmoides*, *Discorbis*, *Cyrodina*

and *Bolivina*. There are also some minute molluscan shells. Studies of the fossil collection by Iqbaluddin indicate that they are shallow marine benthic and of Upper Paleocene to Lower Eocene age. The well data indicate the thickness of the Paleocene-Eocene beds to be about 80 m. The strata mentioned here are bordered on the east by the Malani igneous suite and on the west by exposures of Lathi and Barmer beds. The fossils will be described in detail elsewhere.

#### Semiconducting Polymers

Among polymers there is a group of conjugated-bond polymers. Owing to their "flexible" structure, they show semiconductor properties under certain conditions. Carbon-nitrogen conjugated-bond polymers were first obtained by Academician Valentin Kargin and co-workers. More recently, a group of researchers have synthesized high-molecular carbon-nitrogen conjugated-bond polymers at the Gubkin Institute of Petrochemistry and the Gas Industry.

The reaction was effected between solid salts which were heated to 250-300° C. in an autoclave under a pressure of 20-25 atmospheres in the absence of oxygen. The experiments lasted from five to thirty hours. The new polymers are finely crystalline powders, from light brown to dark brown in colour (depending on the duration of the experiment). They are non-melting substances which begin to decompose at over 700° C.—(*Soviet Science News*.)

#### Space Activities will reduce Van Allen Belt

At the 14th International Astronautical Congress held in September 1963 at Paris, Dr. S. Fred Singer of the U.S. National Weather Satellite Center stated that the hard-radiation inner Van Allen belt surrounding the earth between the two 40° parallels, discovered by satellites in 1958, will be naturally reduced by man's expanding space activities.

When offering, in 1958, his cosmic ray albedo theory (simultaneously developed independently by Soviet scientists) on how the inner Van Allen belt is maintained, Dr. Singer suggested that the high-energy electrons and protons making up the belt are extremely long-lived (measured in hundreds of years). A very small input of high-energy particles, which result from the action of cosmic rays on the earth's atmosphere and are trapped in the belt by the earth's magnetic field, is sufficient to maintain the belt.

Any electron or proton absorber, which any satellite is, will reduce the radiation present in the belt by absorbing these charged particles faster than they arrive.

"Sweeper" satellites, specifically designed for that purpose, may be practical for wiping up man-made radiation belts, resulting from high altitude nuclear explosions.

Data show that the flux of high energy protons has maxima at two different levels in the space above earth. The first, a higher maximum, is at 1.5 earth radii and the second, a lower one, at about 2.2 earth radii. Dr. Singer hypothesized very speculatively that the second peak may exist only in relation to a proton flux intensity "valley" created by the presence of a meteoric dust belt, which absorbs protons, at about 2 earth radii.

### Synthesis of ACTH

R. Schwyzer and P. Sieber of Ciba Limited have reported the complete synthesis of the molecule adrenocorticotrophic hormone (ACTH). The hormone which contains 39 amino-acid sub-units is the largest polypeptide yet synthesized. ACTH is produced by the anterior part of the pituitary gland; it stimulates the adrenal cortex to make a variety of steroid hormones that regulate carbohydrate metabolism and the balance of sodium and potassium in the body fluids. A subsidiary effect of ACTH is to darken the skin by stimulating the activity of the pigment-producing cells melanocytes.

Partial synthesis of the ACTH molecule was reported as early as 1960, by C. H. Li *et al.*, of the University of California, who succeeded in linking together the first 19 amino-acid sub-units of the molecule. This short molecule was found in human subjects to have about 80% of the adrenal stimulating activity of the natural hormone. Later, workers at the Pittsburgh University, and also at Ciba, reported successful synthesis of the molecule up to 24 amino-acid sub-units. Curiously, these shorter molecules showed a greater skin-darkening action than the natural hormones. The explanation is that the first 13 sub-units in ACTH are almost identical with the 13 sub-units found in one form of melanocyte-stimulating hormone (MSH), also produced by the anterior pituitary.

The present report of the synthesis of the complete ACTH molecule should help to clarify how the skin-darkening action of the first 13

sub-units is suppressed by the remaining 26 sub-units.—(*Scientific American*, October 1963.)

### Changes in Earth's Magnetic Poles

According to the results of study on rock magnetism conducted by the U.S. Geological Survey, the direction of the earth's magnetic field was reversed at least twice in the course of geological time. In the period between 980,000 and 1.9 million years ago, and prior to 3.4 million years ago the magnetic north pole lay deep in the southern hemisphere. The present orientation of the field has prevailed for the past 980,000 years, and also existed once before between 1.9 m. and 3.4 m. years ago. These conclusions were drawn from a study of old lava flows in many parts of the world, particularly those in Hawaii and those from Mount Etna in Sicily. The remnant magnetism in volcanic rocks faithfully records the direction of the earth's magnetic field at the time the lava flows took place. In the present study the rocks were dated by the K-Ar dating method.—(*Scientific American*, October, 1963.)

### Summer School on "Molecular Physics" (1964) —Ooty

Under the auspices of the Council of Scientific and Industrial Research and the University Grants Commission, a Summer School on "Molecular Physics" is being organised with special emphasis on current developments. This School is expected to function during the period 17th May to 6th June 1964 in Ooty (Nilgiris). Courses of lectures on the following topics will be delivered by experts in the respective fields: Group Theory; Molecular Orbital Theory and Complexes; Electronic Spectra; Infra-red Spectroscopy; Raman Spectroscopy; Crystal Spectra and Luminescence; Structure Determination by X-Rays; Neutron and Electron Diffraction; Microwave Spectroscopy; and Magnetic Resonance. There will also be Seminar Talks given by specialists followed by discussion on subjects connected with Molecular Physics.

An Organizing Committee has been formed with Professor R. S. Krishnan, Head of the Department of Physics, Indian Institute of Science, Bangalore-12, as the Chairman and Convener. For further particulars, the Chairman may be contacted.



